VOL. XI, NO. 2 JULY, 1942

PROCEEDINGS

OF THE

HAWAIIAN ENTOMOLOGICAL SOCIETY

FOR THE YEAR 1941

HONOLULU, HAWAII

PRICE $2.00

OFFICERS 1941

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Schmidt, Helen B.
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Swezey, O. H.
†Timberlake, P. H.
†Usinger, R. L.
Van Zwaluwenburg, R. H.
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Whitney, L. A.
Williams, F. X.
Zimmerman, E. C.

All correspondence should be addressed to the Secretary, Hawaiian Entomological Society, Honolulu, Hawaii, from whom copies of the Proceedings may be purchased.

Volume I of the Proceedings, for 1905-07 (in five numbers), contains 210 pages, 4 plates, and 5 text figures.

Volume II, 1908-12 (in five numbers), contains 311 pages, 7 plates, 5 cuts, and 1 portrait.

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Volume IV, 1918-20 (in three numbers), contains 610 pages, 10 plates, and 25 cuts.

Volume V, 1921-23 (in three numbers), contains 486 pages, 12 plates, and 34 cuts.

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Volume IX, 1934-36 (in three numbers), contains 468 pages, 19 plates, and 25 cuts.

Volume X, 1937-39 (in three numbers), contains 510 pages, 24 plates, and 30 cuts.

Volume XI, No. 1, 1941, contains 130 pages, 4 plates and 4 cuts.

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PROCEEDINGS

OF THE

Hawaiian Entomological Society

VOL. XI, No. 2 FOR THE YEAR 1941 JULY, 1942

JANUARY 13, 1941

The 421st meeting was held at the H.S.P.A. Experiment Station, on Monday, January 13, at 2:30 p.m. with President Zimmerman in the chair.

Members Present: Miss Bernice Harper, Miss Ethel Lucas, Messrs. Bianchi, Brown, Bryan, Callaghan, Fullaway, Illingworth, Krauss, Look, Mason, McBride, Pemberton, Oakley, Rosa, Sakimura, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

Visitor: August Busck.

The minutes of the preceding meeting were read and approved as corrected.

Dr. G. D. Hale Carpenter was elected as a corresponding member.

The Secretary read a note of appreciation and thanks from Dr. L. O. Howard for his election as Honorary member of the Society. A letter from the Zoological Society of London asking for funds to aid in publishing the Zoological Record was read. It was moved, seconded and passed that the Secretary-Treasurer send the Zoological Society of London $25.00 for this purpose.

The secretary-treasurer read the financial statement of the Society, for the year ending December 5, 1940. The president appointed Mr. R. H. Van Zwaluwenburg to audit the financial statement.

The matter of publishing the Index to Proceedings Hawaiian Entomological Society, Vol. X was brought up by Mr. Otto Swezey. The secretary thought there would be sufficient funds for this. A discussion re publishing the index for volumes I-X followed and it was voted that a meeting of the Editorial Committee be called to consider the matter.

PAPER

Dr. J. F. Illingworth presented a paper entitled: "An Outbreak of Cockroaches, *Nauphoeta cinerea* (Olivier), in Honolulu".

NOTES AND EXHIBITIONS

Adoretus sinicus Burm.—Dr. Illingworth exhibited old leaves of a Cycad plant growing in his yard at Kaimuki. Since the Cycad is

a favorite food plant of the oriental rose beetle, the perfect foliage is a good indication of the scarcity of this pest during the past season. Leaves from the same plant, shown at our meeting May 6, 1937, were badly damaged, being only a network of fibers from end to end. Subsequent to that time the imported Bufo have become very abundant, and breed in an open fish pond in the yard.

Anomala orientalis (Waterhouse).—Mr. Sakimura reported that the pineapple fields in the area south of Wahiawa and Schofield Barracks have been recently surveyed for *Anomala* distribution. The extent of infestation in the pineapple fields was found to be much larger than that expected, and the whole area was generally infested. Kupehau, Kunia, Robinson, Kipapa, Pine Spur, Waipio, Waiawa are all within the infested area. *Anomala* grubs could not be found at Sanitarium Flat and Leilehua. The boundary of known distribution is now within a mile, at the shortest, from Wahiawa or Wheeler Field. Severe injuries on pineapple plant are now noticeable only at Kunia and Robinson. A brief survey disclosed that the grubs were not found in a pineapple field at Red Hill which is the nearest pineapple field from Honolulu and is far out from the boundary of the present known distribution within the sugar cane fields.

Listroderes obliquus (Gyll.)—Mr. Zimmerman reported that in January a package containing Hawaiian artifacts was sent to Bishop Museum from Kamuela, Hawaii, and in the excelsior packing there was found a series of the vegetable weevil. Nine living specimens and numbers of mashed specimens were removed from the excelsior in the small package received. It may have been that the weevils had had access to and had hidden in the excelsior before it was used as packing. The weevil is apparently common at Kamuela. This interception indicates how easily the weevil may be transported to new areas although it is not in company with any of its food plants. This insect was first described from the southern end of South America and has spread widely and rapidly in recent years. It has found its way to many favorable localities in North and South America and is in Australia and South Africa. Mr. Swezey found it in Hawaii for the first time in 1926 on the island of Hawaii.

Melophagus ovinus (Linn.) — Mr. Van Zwaluwenburg mentioned recent correspondence with Dr. J. C. Bequaert of the Harvard Medical School concerning the presence of this hippoboscid parasite of sheep in Hawaii. According to Dr. Bequaert the records from the island of Hawaii are the only ones so far from Oceania, although the species is known from Australia, Tasmania and New Zealand. The earliest record from Hawaii is by Muir (P.H.E.S., vii, 4) from a specimen taken on a bag of forest seeds collected "in a strip of forest adjacent to a sheep run in Honohina [Hawaii]" in December 1926. On October 4, 1931 Swezey and

Williams (P.H.E.S., viii, 188) collected a specimen in the saddle room at Keanakolu, at an elevation of 5250 feet. If the first record is from a point farthest inland in the Honohina district (there is now no way of determining the exact location) the two localities are not less than six miles apart, and possibly considerably more. It would seem reasonably certain that the insect is established on wild or domesticated sheep on the eastern slopes of Mauna Kea, since it was collected some five years apart. In the absence of other records it is impossible to define the extent of its range on Hawaii, and it is suggested that collectors having access to the uplands of that island gather further information as to its distribution and prevalence.

FEBRUARY 10, 1941

The 422nd meeting was held at the H.S.P.A. Experiment Station, on Monday, February 10, 1941, at 2:30 p.m. with President Zimmerman in the chair.

Members Present: Miss Ethel Lucas, Messrs. Bianchi, Bryan, Fullaway, Illingworth, Look, McPhail, Pemberton, Rosa, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

Visitor: August Busck.

The minutes of the preceding meeting were read and approved.

Mr. R. H. Van Zwaluwenburg stated that he had audited and found correct the report of the treasurer for the year ending December 5, 1940.

PAPER PRESENTED

Mr. August Busck presented and discussed a paper entitled: "On the Making of Genitalia Slides of Lepidoptera."

NOTES AND EXHIBITIONS

Pectinophora gossypiella (Saund.).—Mr. Swezey exhibited specimens of the pink bollworm moth which he had reared from the seeds of *Thespesia populnea*. He had collected 30 capsules from trees at Kokokahi, by the shore of Kaneohe Bay, January 25, 1941. From these 30 capsules 8 pink bollworm moths have already issued. There also issued one parasite (*Pristomerus hawaiiensis*) and one *Opogona aurisquamosa*. Mr. Swezey had never before found this moth so abundant in *Thespesia* capsules.

Cycloptilum bimaculatum (Shiraki). — Mr. C. E. Pemberton stated that specimens of this wingless "bush cricket" were sent to Mr. C. F. W. Muesebeck, In Charge, Division of Insect Identification, U.S. Bureau of Entomology and Plant Quarantine, for identification. In a letter dated January 14, 1941, Mr. Muesebeck states that A. B. Gurney had identified the cricket as above. It was originally described from Formosa. A number of specimens of this

cricket were collected on Alewa Heights, Honolulu, and exhibited at a previous meeting of this Society. To date it has not been found elsewhere in Hawaii.

New host of Dioctes chilonis Cushman.—Mr. Van Zwaluwenburg exhibited an adult ichneumonid wasp identified as this species by Dr. Williams, bred from a cocoon found in a tunnel of the sweet potato moth borer, *Omphisa anastomosalis* Guenee, and presumably parasitic on that pyralid. The cocoon was collected February 4 in Field 81, Ewa Plantation Company; the wasp issued on February 10. *Dioctes chilonis* was introduced by F. C. Hadden from China in 1928 as a parasite of the rice borer, *Chilo simplex* (Butler), on which it is established on Oahu and Kauai. Miss Lucas mentioned that she also had bred *Dioctes* from *Omphisa.*

Ampulex compressa (Fab.).—Dr. F. X. Williams spoke of the longevity of one of these wasps caught in a garden in Noumea, New Caledonia, on October 31, 1940. Designated as wasp No. 3, she parasitized several dozen *Periplaneta* cockroaches, and died on February 10, 1941, a life of 102 days in captivity.

MARCH 10, 1941

The 423rd meeting was held at the H.S.P.A. Experiment Station, on Monday, March 10, 1941, at 2:30 p.m. with President Zimmerman in the chair.

Members Present: Miss Bernice Harper, Miss Ethel Lucas, Messrs. Bianchi, Bryan, Callaghan, Fullaway, Goolsby, Holdaway, Illingworth, Krauss, Oakley, Pemberton, Rosa, Schmidt, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

Visitor: Mr. William J. Clench.

The minutes of the preceding meeting were read and approved. Out of respect for the late Mr. E. M. Ehrhorn, the president asked that the members stand for sixty seconds.

Mr. Otto Swezey presented resolutions, as follows:

Edward Macfarlane Ehrhorn

Whereas in the death of Mr. Edward Macfarlane Ehrhorn on February 10, 1941, the Hawaiian Entomological Society has suffered the loss of one of its most devoted and oldest members, therefore

Be it resolved, that the Hawaiian Entomological Society hereby records its grievous loss and expresses appreciation of his keen interest and participation in the affairs of the Society, of which he served as its President in 1911, 1915, Vice-President in 1935; and

as a member of the Executive Committee for the years 1919, 1930, 1931, 1932 and 1933; and to which he contributed papers and numerous notes on entomological observations for printing in the Proceedings of the Society, and

Be it further resolved, that a biographical sketch be prepared for printing in the Proceedings of the Hawaiian Entomological Society, and

Be it further resolved, that a copy of these resolutions be sent with expression of deep sympathy to the bereaved family.

President Zimmerman then appointed Mr. O. H. Swezey, as chairman, with D. T. Fullaway and F. X. Williams as a committee to write a biography of Mr. Ehrhorn.

BIOGRAPHICAL SKETCH

Edward Macfarlane Ehrhorn
(1862-1941)

The death of the veteran entomologist and plant quarantine inspector, Edward Macfarlane Ehrhorn, occurred February 10, 1941, at the Queen's Hospital in Honolulu, after a short illness. At his death, Mr. Ehrhorn was 79 years of age. During the last 31 of these years his residence had been in Honolulu.

Most of Mr. Ehrhorn's earlier life was spent in California. He was born in San Francisco, January 24, 1862. During his childhood years, he was sent to Germany, where he was educated in German schools, 1871-1878, later studying a year at Grenchen, Switzerland and at Brighton College, England. He studied entomology at Stanford University, California, after which he was deputy quarantine officer for the California State Board of Agriculture for 1891, and county entomologist and horticulture commissioner for Santa Clara County, California, 1892-1904. From 1904 to 1909 he was first deputy state commissioner of horticulture and horticultural quarantine officer at San Francisco, California. At this time he was very active as a collector and made many field excursions in California, extended at times into the Southwest and Mexico. His close association with and great friendship for Dr. L. O. Howard, Chief of the Federal Bureau of Entomology, led to his appointment to the Gypsy Moth Commission.

Mr. Ehrhorn came to Honolulu in 1909 as superintendent of entomology at the Territorial Board of Agriculture and Forestry, after the death of Mr. Alexander Craw, who had organized the plant quarantine service in 1904. When the plant inspection was organized as a separate division in 1916, Mr. Ehrhorn was placed in charge of it, a position which he held until being retired in 1926, after which he served in advisory capacity as Consulting Entomologist.

Edward Macfarlane Ehrhorn

Mr. Ehrhorn was elected to active membership in the Hawaiian Entomological Society, November 4, 1909; therefore, was one of the very few who remained of the early members. He was president of the Society during the years 1911, 1915, and vice-president in 1935. Numerous notes and exhibitions were contributed at the monthly meetings of the society; several papers were presented, which are listed at the end. His special interests were the mealybugs, scale insects, ants, and termites. After his retirement as chief plant inspector in 1926, several years were devoted to termite control work in Honolulu, particularly in connection with several downtown business blocks.

Aside from entomology, Mr. Ehrhorn was keenly interested in botany and horticulture. At his home grounds in Manoa Valley are numerous examples of his success in hybridizing cannas, cactus and crotons. Many other novelties in ornamental plants are also present.

Other scientific societies of which he was a member are: American Association for the Advancement of Science, American Association of Economic Entomologists, Entomological Society of America, Pacific Coast Entomological Society, California Academy of Natural Sciences, Hawaiian Academy of Science, Hawaiian Botanical Society.

The University of Hawaii conferred upon Mr. Ehrhorn the honorary degree, Master of Science, in 1932, at which time he was lecturer in horticulture at the University.

Mr. Ehrhorn was a member of the Fraternal Orders: Elks, Masons, Shriners.

He married Miss Jane Jones in 1927, who survives him. He also has two brothers and two sisters living in California.

Papers by Mr. Ehrhorn in the Proceedings of the Hawaiian Entomological Society:

1912 A few Notes on Coccidae, II, pp. 147-150, Pl. 5.

1912 Gall-making Coccidae, II, p. 179.

1913 Notes on the large House Spider, Heteropoda regia, II, p. 196.

1913 Suggestions for the Future Growth of the Hawaiian Entomological Society (Annual Address), II, pp. 203-205.

1914 Pseudococcus Species found on Sugar Cane in Hawaii, III, pp. 1-3.

1916 Contributions to the Knowledge of the Dactylopiinae of Hawaii (Annual Address), III, pp. 231-247.

O. H. Swezey
F. X. Williams
D. T. Fullaway.

The subject of Biological Abstracts having been brought up and discussed Dr. Carl Schmidt made a motion, "that the president appoint a member of the Society to supply biological abstracts of each paper appearing in the proceedings of the Hawaiian Entomological Society." The motion was seconded by Mr. C. E. Pemberton, and passed. The president then appointed Mr. E. H. Bryan for this task.

PAPERS PRESENTED

On behalf of Mr. W. S. Fisher, U.S. Dept. of Agriculture, Mr. R. H. Van Zwaluwenburg presented a paper entitled "A New Species of Trixagus from the Hawaiian Islands" (Coleoptera: Trixagidae). On behalf of Dr. Schedl, Mr. O. H. Swezey presented a paper on Hawaiian Scolytidae and Platypodidae, which will be published along with Mr. Swezey's paper "Notes on Food-Plant Relations of Scolytidae and Platypodidae in the Hawaiian Islands." (See Proc. Haw. Ent. Soc., XI: 109-117, 1941.)

NOTES AND EXHIBITIONS

Dioctes chilonis Cushman.—Mr. Bianchi stated that in a collection made from four sweet potato vines grown at Ewa Plantation he had found seven cocoons of the ichneumonid *Dioctes chilonis* and only six unparasitized larvae of *Omphisa anastomosalis,* the sweet potato stem borer. This indicates that the paucity of records hitherto available has not truly pictured the importance of *Dioctes* as a factor in the control of this serious pest.

Cerambycobius cushmani Crawf.—Mr. Bianchi stated that he had recently bred this parasite from larvae of the sweet potato weevil, *Euscepes postfasciatus,* collected at Ewa and Waipahu on this island. This constitutes a new record for *Cerambycobius,* which is found to attack *Euscepes* larvae of a very wide range of development but unfortunately seems able to reach only larvae boring in the aerial branches of the host plant, attacking there only those larvae which may be near the surface or exposed by breaks in the tissues of the plant. Probably for this reason the importance of *Cerambycobius* as a check on *Euscepes* appears to be small, the percentage of parasitism among several large collections from Oahu Sugar Plantation not exceeding 5%.

Dendrothripoides impomeae Bagnall.—Mr. Bianchi stated that this thrips, of which he had previously found only a single specimen on grass at Kailua, Oahu, (See Page 38, Proc. Haw. Ent. Soc. Vol. XI, No. 1, 1941) is now quite common on sweet potatoes at Ewa Plantation. The eggs are laid, in the usual terebrantian manner, just under the epidermis of the soft, new shoots of the plant and both young and adult thrips are far more common in these areas than in the drier and tougher parts of the plant. Contrary to reports from other countries, no visible damage is done to the host plant by *Dendrothripoides* populations of the moderate density so far

observed in Hawaii and there is even some indication that the thrips may be beneficially predatorial on the eggs of the sweet potato leaf miner, *Bedellia orchilella.* The point, however, needs further elucidation.

Puliciphora sp.—Mr. Bryan exhibited two slides of this phorid which had been submitted to him by the Hawaii Agricultural Experiment Station. Professor C. T. Brues had identified the flies as males of *Puliciphora* sp., stating that species of this genus were so poorly known that he could not attempt to attach a specific name. The specimens had been bred at the experiment station from the larvae of *Lycophotia margaritosa,* collected on Maui by T. Yoshida, Jan. 14, 1940. Dr. Brues thought that these flies were not parasitic, but that they had attacked the caterpillars after they were dead, that being the habit in this genus.

Dr. Carter reported injury to mango flowers at Kapaa, Kauai by *Elimaea punctifera* (Walker) and *Holochlora japonica* (Brunn.). The latter species is apparently a new record for that island. Specimens were received from Mr. Bernard Pratt on January 3, 1941. Specimens were exhibited.

Mr. D. T. Fullaway exhibited and discussed *Megamelus davisi,* a recent leafhopper (Delphacidae), immigrant to these Islands, having been taken on Nymphea water lilies, at Aiea, Oahu.

Mr. R. H. Van Zwaluwenburg said that the salt-water strider at Canton Island had recently been determined by Dr. R. Usinger, as *Halobates micans* Esch.

Mr. C. E. Pemberton exhibited an attractive species of encyrtid wasp, possibly a new species, which he found on the laboratory window.*

Mr. E. C. Zimmerman introduced Mr. W. J. Clench, head of the Department of Malacology Museum of Comparative Zoology, Harvard University.

APRIL 14, 1941

The 424th meeting was held at the H.S.P.A. Experiment Station, on Monday, April 14, 1941 at 2:30 p.m., with President Zimmerman in the chair.

Members Present: Miss Ethel Lucas, Messrs. Carter, Fullaway, Holdaway, Look, Mason, McBride, Pemberton, Rosa, Schmidt, Swezey, Van Zwaluwenburg, Williams and Zimmerman.

The minutes of the preceding meeting were read and approved as corrected.

Mr. O. H. Swezey reported for the publication committee that the material for the 1940 Proceedings had been assembled and that it would make a small number.

* Later on, specimens of the same insect were found on windows at the Pineapple Research Institute. Some specimens were sent to Mr. Harold Compere for determination, who found them to be of an undescribed species of *Metaphycus,* or a closely related genus.

PAPER PRESENTED

Dr. Carl T. Schmidt presented a paper entitled, "Ear Worm Control in Sweet Corn", and discussed it briefly.

NOTES AND EXHIBITIONS

New Aleurodid in Hawaii—Mr. Swezey exhibited leaves of the star jasmine badly infested by an aleurodid which appeared new to him; also a slide mount of the insect. It is distinctly different from *Aleyrodes kirkaldyi* Kotinsky which was described from Hawaii in 1907 as occurring on a species of jasmine. (Board of Agriculture and Forestry of Hawaii, Ent. Bull. 2, p. 95, Pl. I, figs. 2a-d, 1907). Mr. Swezey found a considerable infestation by this aleurodid on the University of Hawaii campus, April 12, 1941.

Volucella pusilla Macquart.—Mr. Swezey reported on rearing this syrphid fly from rotten panini (*Opuntia*), brought in by Mr. Tom McGuire from Waianae, Oahu, March 4, 1941. Mr. McGuire thought that the cactus was dying out from insect attacks. Maggots of this fly were the only insect forms found in the material, and one fly was reared. This fly has been reared previously from rotten branches of night blooming cereus, presumably where the maggots were secondary to some other injury.

Euhyposmocoma asplenii Meyrick. — This name is found in Fletcher's "List of Generic Names used for Microlepidoptera", published as Indian Entomological Memoir, XI, *asplenii* being designated as genotype of Swezey's genus *Euhyposmocoma*. Mr. Swezey reported that he had made an exhaustive search in literature for *asplenii*, without finding any record of why Meyrick had substituted the name *asplenii* for *ekaha*, which was designated by Swezey as the type when he erected the genus *Euhyposmocoma* (Proc. Haw. Ent. Soc., II, p. 277, 1913). Mr. Zimmerman had recently received an explanation from Mr. Fletcher, to whom he had written for a possible solution of the difficulty. Mr. Fletcher had been able to trace the name *asplenii* Meyrick to a list which he had copied from Meyrick's manuscript "List of Genonyms", where he had given *asplenii* as type of the genus *Euhyposmocoma*. Fletcher states that it is obvious that Meyrick considered *"ekaha"* as a barbarous and nonclassical name and so renamed the species *asplenii*, but this was in an unpublished manuscript. Hence where Fletcher had used it in his "List", it was merely a *nomen nudum*, and he states that *ekaha* therefore stands as the genotype of *Euhyposmocoma*.

Dr. F. G. Holdaway exhibited specimens of *Nysius nemorivagus* White which has been recorded attacking Chinese cabbage and cucumbers in the Kilauea Volcano district of Hawaii (4,000 ft.) during Oct. 1939, Feb., April and May 1940 and on Chinese cabbage May 1940, Kona, Hawaii. At Kilauea it also attacked hard-skinned squash. At Kona adults were found in numbers around roots of *Solanum nodiflorum* in Chinese cabbage fields. Only once

before has this lygaeid been recorded attacking an economic plant in Hawaii. In June 1933 Dr. M. B. Linford found it attacking the terminal shoots of Irish potato plants on Parker Ranch, Hawaii, (5,850 ft.) and causing severe wilting.

On behalf of Mr. Noel Krauss, Mr. D. T. Fullaway recorded that the fruit fly *Rhagoletis cingulata* Loew., was reared in quarantine from cherries imported from the northwest. The fruitfly larvae were so identified by Mr. Greene of the United States National Museum.

Mr. E. C. Zimmerman spoke of Mr. O. H. Swezey's very useful paper: "Observations on Insect Pests in Samoa which are not yet known to occur in Hawaii" and which has just been published in the Hawaiian Planters' Record (XLV, No. 1, 1941).

MAY 12, 1941

The 425th meeting was held at the H.S.P.A. Experiment Station, on Monday, May 12, 1941, at 2:30 p.m., with President Zimmerman in the chair.

Members present: Misses Bernice Harper and Ethel Lucas; Messrs. Browne, Bryan, Holdaway, Illingworth, Keck, Look, Oakley, Pemberton, Swezey, Van Zwaluwenburg and Zimmerman.

The minutes of the previous meeting were read and approved.

Dr. Holdaway, for the committee on common names, reported that the revision of the list of common names is now complete to date. After discussion it was suggested that the list be mimeographed and placed in the hands of entomologists, county agents and others in the Territory who can make use of it.

The name of Mr. Franklin Shuey was proposed for membership.

It was moved by Mr. Swezey, seconded and passed, that the President be given credentials from the Society for presentation when he attends the June meetings of the American Association for the Advancement of Science, and affiliated societies, at Pasadena, California.

After discussion it was moved by Mr. Bryan, seconded and passed, that the President present at the next meeting information with a view to the possible affiliation of this Society with the Pacific Coast Branch of the American Association for the Advancement of Science.

Mr. Zimmerman made a plea for a more general use of author names in notes and papers presented for publication in the Proceedings, and pointed out the confusion often arising from abbreviation of author names. A motion supporting his remarks was moved by Mr. Bryan, seconded by Mr. Pemberton, and passed unanimously.

Honeybee pollen.—Mr. Keck exhibited a jar containing six and one-half pounds of pollen, taken by means of a pollen trap, from ten colonies of honeybees over a period of five days. Not only is there a possible sale for pollen to mainland beekeepers to tide colonies over winter shortages, but there is, in addition, the possibility of substituting pollen in poultry feeds locally for wheat middlings as a source of protein. Prof. C. M. Bice of the University of Hawaii is using the pollen in a feeding experiment with young chicks. Analysis of the local pollen shows 19.3 per cent protein and 22 per cent fiber. Mr. Keck stated that in California as much as 40 pounds per season can be trapped from a single colony.

Hawaiian Oechalia.—Mr. Swezey exhibited a collection of 12 species of bugs of the genus *Oechalia* which were returned by Mr. R. L. Usinger who had recently completed an extensive paper on this genus of bugs.

Hierodula patellifera (Serville).—Mr. Swezey exhibited a specimen of this mantis which was collected Jan. 2, 1941 at Hanapepe, Kauai by Mr. F. Tom, a student at the University of Hawaii. It is the second specimen of this species which he had seen, the first having been collected at Waimea, Kauai in April 1924.

Blow flies attacking young calves.—Dr. Holdaway exhibited specimens of the following:

1. Adults of *Chrysomyia megacephala* (Fab.) and *Lucilia sericata* (Meigen) reared from "fly-struck" calves up to two weeks old, with larvae of both these species.
2. Adults of *Chrysomyia megacephala* and *Chrysomyia rufifacies* (Macquart) collected on and breeding in a dead calf with larvae of *C. rufifacies.*
3. Adults of *Cryptolucilia caesarion* (Meigen) and *Chrysomyia megacephala* reared from wet cow dung.

Dr. Holdaway stated that during November and December 1940 a number of calves had died on Kauai as a result of "fly-strike." One large ranch lost ten calves representing 25 per cent of the calves born to that time before it was realized what the cause was. An additional 24 calves were blown, making a total of 34 calves struck, or 46 per cent of the calves born. One small ranch reported that *all* calves of 11 born during the year died, apparently as a result of fly attack. In general the calves were attacked soon after birth and during the first two months of life. While both *Lucilia sericata* and *Chrysomyia megacephala* reared from "fly-struck" calves, the latter is apparently the more important. It is the most abundant fly breeding in carcasses. One specimen of *C. megacephala* was reared from wet cow dung. The majority of the green flies reared from cow dung were *Cryptolucilia caesarion. C. megacephala* has been recorded as attacking sheep in Hawaii but has not previously been recorded as causing the death of new-born calves.

Pinnaspis buxi on Pandanus.—Mr. Browne presented the following note: While on Molokai early in April my attention was called to lauhala in the Pukoo area because the local residents complained that the leaves were stained and unfit for weaving. Examination showed a very heavy infestation of *Pinnaspis buxi* (Bouché). Local weavers who derive a considerable portion of their income from the trees, as well as social workers on Molokai, are much concerned about possible control measures. Steps have been taken to secure and release the predatory coccinellid *Telsimia nitida* Chapin.

JUNE 9, 1941

The 426th meeting was held at the H.S.P.A. Experiment Station on Monday, June 9, 1941, at 2:30 p.m. In the absence of both president and vice president, Ashley C. Browne was asked to preside.

Members present: Miss Bernice Harper, Messrs. Browne, Bryan, Carter, Keck, Pemberton, Rosa and Van Zwaluwenburg.

The minutes of the previous meeting were read and approved. Mr. Franklin Shuey was unanimously elected to active membership.

A letter was read from Dr. J. Murray Luck, secretary of the Pacific Division of the American Association for the Advancement of Science, giving further details concerning association with the Pacific Division and affiliation with the national organization. After some discussion it was moved, seconded and carried that the Society withhold action on this matter until arrangements can be made to investigate affiliation with the national organization of the A.A.A.S.

PAPERS PRESENTED

On behalf of Mr. Zimmerman, the following paper was presented: "A New Scydmaenid from Hawaii (Coleoptera)".

Also presented for Mr. Zimmerman was his paper entitled: "A New Phanerostethus from New Caledonia (Coleoptera: Curculionidae)".

NOTES AND EXHIBITIONS

Orb web spider preying on Scolia.—Dr. Carter exhibited three adult *Scolia manilae* Ashmead taken in the web of *Argiope avara* Thorell in a pineapple field at Wahiawa, March 25. Each wasp was tightly rolled in a silk web, and although alive when found, was utterly helpless. Mr. Pemberton commented on the reduced numbers of this spider of recent years due to the ichneumonid parasite of spider eggs, *Tromatobia rufopectus* (Cresson).

Colobicus parilis Pascoe—Mr. Van Zwaluwenburg reported the emergence on June 3 of this colydiid beetle from sweet potatoes brought into the laboratory on May 2. Colydiids vary in habit from

true parasites to scavengers; it is not known if this beetle was predaceous upon the numerous *Euscepes* larvae infesting the sweet potatoes, or if it fed upon the decaying vegetable matter present.

Another parasite of the sweet potato stem borer.—Mr. Van Zwaluwenburg reported rearing the native braconid, *Chelonus blackburni* Cameron, from a pupa found in the tunnel of *Omphisa anastomosalis* Guenee, in Field 61, Oahu Sugar Co., on May 20. This is a hitherto unrecorded enemy of this pyralid pest.

JULY 14, 1941

The 427th meeting was held at the H.S.P.A. Experiment Station, Monday July 14, 1941 at 2:30 p.m. In the absence of both president and vice-president Mr. O. C. McBride was asked to preside.

Members present: Messrs. Keck, Oakley, Pemberton, Rosa, Van Zwaluwenburg and Williams.

Visitor: Douglas Worcester.

The minutes of the previous meeting were read and approved.

PAPERS PRESENTED

Mr. Van Zwaluwenburg discussed, and presented, by title, a paper concerning a new species of Subprotelater (Eucnemidae) taken by F. X. Williams in New Caledonia in 1940.

On behalf of Prof. C. T. Brues, F. X. Williams presented a paper entitled "Rediscovery of *Leucospis antiqua* Walker in New Caledonia". The insect involved is a large chalcid that greatly resembles at first sight an eumenid wasp occurring in the same region.

Mr. R. G. Oakley discussed the status of parasitization of the rice borer *Chilo simplex* at Waipahu, Oahu.

Mr. C. B. Keck discussed the feeding of bee pollen to chickens, as a possible substitute for wheat middlings.

AUGUST 11, 1941

The 428th meeting was held at the H.S.P.A. Experiment Station, Monday August 11, 1941 at 2:30 p.m. In the absence of both president and vice-president Mr. E. H. Bryan, Jr., was asked to preside.

Members present: Miss B. E. Harper, Messrs. Bryan, Carter, Keck, McBride, Rosa, Van Zwaluwenburg and Williams.

Visitor: Douglas Worcester.

The minutes of the previous meeting were read and approved.

NOTES AND EXHIBITIONS

Dr. Walter Carter spoke of his experiments with the pineapple mealybug *Pseudococcus brevipes*. He induced these insects to insert their beaks in plain agar. Thus, for the first time insect feeding tracks were produced outside plant tissues. The mealybug ejects saliva, that congealing around the stylets, forms a very slender cylinder, plainly visible under the microscope. Dr. Carter also showed photographs of these feeding tracks.

Mr. E. H. Bryan, Jr., exhibited some leeches taken in the Hawaiian Islands and sent to Professor J. Percy Moore of the University of Pennsylvania for determination. These determinations were: *Glossiphonia weberi* and *Barbronia weberi* subspecies *formosana*. Both these fresh water species are also common in the orient.

SEPTEMBER 8, 1941

The 429th meeting of the Hawaiian Entomological Society was held at the H.S.P.A. Experiment Station, on Monday, September 8, 1941 at 2:30 p.m., Mr. O. H. Swezey presiding.

Members present: Miss Bernice Harper, Messrs. Keck, Marlowe, Pemberton, Rosa, Sakimura, Swezey and Williams.

The minutes of the previous meeting were read and approved.

The Secretary reported that the Executive Committee had approved the bill of $480.38 for printing "Proceedings," Vol. XI, No. 1.

Mr. O. H. Swezey kindly took over the unfinished data of indexing Proceedings of the Hawaiian Entomological Society, Vol. X, from Mr. E. H. Bryan, Jr., whose added duties prevent his completion of it.

NOTES AND EXHIBITIONS

Liposcelis divinatorius Mull.—Mr. Pemberton exhibited a half pound of polished rice which was gradually being reduced to powder by this insect. The rice had been kept in a glass jar with a tight cloth cover for 4½ months and had been sterilized with heat prior to being placed in the jar. The psocids had evidently gained entrance to the jar after the rice had been placed in it and had multiplied tremendously. Many hundreds could be seen in and over the hollowed kernels of rice. Prior to sterilization the rice had been injured by the rice weevil *Calandra oryzae* L.

Ampulex compressa (Fabr.).—Dr. F. X. Williams reported finding this wasp—imported Nov. 1940 from Noumea, New Caledonia—common on a chicken shed at the University of Hawaii poultry farm, on August 22, 1941. Adult wasps had been liberated there on March 4 and May 2, 1941. Previously, on July 23 to Sept. 4, 1941 he had noticed a male *Ampulex* on the trunk of a "Yellow

Shower" (Cassia) at upper Keeaumoku St., some distance from any point of liberation. The wasp is probably established here.

Tiphia segregata Crawford.—Dr. F. X. Williams reported on his findings re this wasp at Kailua, in late August. The insect was first observed early in August 1941 at Kailua by Messrs. Pemberton and Van Zwaluwenburg. The *Tiphia segregata* parasitized only *Anomala* spp. Introduced into the Hawaiian Islands in 1917, it was found years later parasitizing only *Anomala orientalis* in the cane fields of Oahu Sugar Plantation. However, at Kailua, Oahu, where *Anomala* has never been found, but where *Adoretus sinicus* Burm. abounds, the wasp was found parasitizing larvae of *Adoretus* in precisely the same manner as it parasitizes *Anomala*. Between 40 and 30 *Adoretus* grubs were collected in the Kailua vegetable gardens and of these 2 showed a *Tiphia* egg glued near the apex of the abdomen. Two *Tiphia* wasps confined with *Adoretus* grubs lost no time in parasitizing them.

Mr. C. E. Pemberton said this was the first record of *Tiphia* here outside the *Anomala* area and he suggested the adaptation of *Tiphia segregata* to *Adoretus* grubs might constitute a biological race of this wasp.

Mr. Pemberton also remarked that years ago large numbers of *Tiphia lucida* Crawford, an *Adoretus* parasite, were imported from the Philippines and liberated on Oahu. The wasp has never been found here.

Meligethes aeneus (Fab.).—Mr. Swezey exhibited a specimen of this nitidulid beetle collected by him at Springfield, Oregon, July 22, 1941, where it was very abundant on flowers of *Sonchus*, dandelion and other weeds and garden plants. This species is peculiar in that the elytra completely cover the abdomen. It is an European species, where it is known as the rape flower beetle and considered a pest. The specimen was identified by comparison with a specimen in the Giffard collection of California beetles labelled *Meligethes brassicae*, which in the Leng catalog is synonymized with *aeneus*. The specimen exhibited was the more remarkable in that during a tour of two months on the mainland, it was the only insect specimen collected.

Pasadena Entomological Meetings.—Mr. Swezey gave an account of his attendance at the meetings of the Pacific Slope Branch of the American Association of Economic Entomologists at Pasadena, California, June 18-20. The attendance was unusually large, about 300 being registered, though there were not that many present at any one time. There were sessions for three days, and one evening was taken up with a symposium on "Relationships between Systematic and Economic Entomology", which was about the most interesting of the sessions. There were 57 papers on the complete program, many of them having to do with modern insecticides and the results of experiments in their use to control orchard

pests. He met many old acquaintances at the meetings, but the majority in attendance were a younger generation of entomologists who displayed great enthusiasm in their own respective lines of research. A banquet was held one evening at which 150 participated. After the close of the meeting, Mr. Swezey visited a number of entomologists at their respective offices, laboratories or homes: Messrs. Pierce and Comstock at the Los Angeles Museum; Timberlake and Compere at Citrus Experiment Station, Riverside; Hermes, McLeod, Essig, Light and Linsley at Berkeley; Mackie at Sacramento; Usinger, Eckert, and Stewart at Davis; Armitage and Ting at Plant Quarantine Dept., San Francisco; Smyth at Glen Ellen, Calif.; Reeves at Salt Lake City; Erhard at Field Museum, Chicago.

OCTOBER 13, 1941

The 430th meeting of the Hawaiian Entomological Society was held at the H.S.P.A. Experiment Station, on Monday, October 13, 1941 at 2:30 p.m., Vice-President O. H. Swezey presiding.

Members Present: Messrs. Browne, Holdaway, Ito, Keck, Krauss, Look, Marlowe, Oakley, Pemberton, Rosa, Swezey, Van Zwaluwenburg and Williams.

Visitor: T. Nishida.

The minutes of the previous meeting were read and approved as corrected.

Mr. O. H. Swezey stated that the Hawaiian Sugar Planters' Association had paid for printing the Proceedings, Vol. XI, No. 1. It was moved by Mr. C. B. Keck and seconded by Mr. R. H. Van Zwaluwenburg that the Society extend its thanks to the Hawaiian Sugar Planters' Association. Passed.

Mr. O. H. Swezey said that he had finished indexing Volume X of the Proceedings and that it was now in press.

PAPERS PRESENTED

Mr. K. Ito presented a paper entitled: "Seasonal Trend in the Development of the Sex Forms of the Fire Ant, *Solenopsis geminata* Fab. var. *rufa* Jerdon, in the pineapple fields of Oahu." Mr. Ito briefly discussed this paper.

Mr. R. H. Van Zwaluwenburg presented a paper entitled: "Notes on the Temporary Establishment of Insect and Plant Species on Canton Island".*

NOTES AND EXHIBITIONS

Ctenolepisma urbana Slabaugh.—Dr. F. G. Holdaway reported that Miss Eder Lindsay had recently examined the common silver-

* Published in The Hawaiian Planters' Record, vol. XLVI, No. 2, 1942.

fish infesting University buildings and had identified it as *Ctenolepisma urbana* Slabaugh, which was described in Entomological News, p. 95, Pl. III, 1940. The name *Lepisma saccharina* which had been tentatively used in the list of common names of insects in Hawaii has therefore been changed to *Ctenolepisma urbana* Slabaugh.

Agromyzid leafminer in Scaevola from Canton Island.—Mr. Van Zwaluwenburg exhibited an agromyzid fly bred from leafmines in *Scaevola frutescens* (Miller) Krause on Canton Island. This fly is not yet identified, but may be the same species (also unidentified) which Mr. Swezey found associated with leafmines in *Scaevola* in Guam and in Samoa. From *Scaevola* mines Mr. Van Zwaluwenburg also bred a female parasite determined by C. E. Pemberton as an eulophid. This is the first insect parasite known from Canton with the exception of the two recently introduced species, *Evania appendigaster* (L.) and the scelionid *Telenomus nawaii* Ashmead, both of which are now established there.

Proterhinus tantali Perkins.—Mr. Swezey reported on collecting 13 of this beetle on *Euphorbia* Sept. 28, 1941, at the place on Mt. Tantalus, and from the same clump of bushes from which he had collected the original lot of specimens April 22, 1934. This was the last species of *Proterhinus* described by Dr. Perkins. It has not yet been recorded from any other place than the original locality. Other species of *Proterhinus* attached to *Euphorbia* are: *bridwelli* Perkins on Maui; *bryani* Perkins on Nihoa; *euops* Perkins, Mt. Kaala; *euphorbiae* Perkins, Mt. Kaala, Kukuiala Val. and Lanihuli; *impressiscutis* Perkins, Mt. Kaala; *impressiscutis* var. *nudior* Perkins, Hauula, Kahauiki, Lanihuli and Kuliouou; *obscurus* var. *chryseis* Perkins, Koolau Mts. from Kuliouou to Kahana. This is a total of 6 species and 2 varieties.

NOVEMBER 10, 1941

The 431st meeting of the Hawaiian Entomological Society was held at the H.S.P.A. Experiment Station, on Monday, November 10, 1941, at 2:30 p.m., Vice-President O. H. Swezey presiding.

Members present: Messrs. Browne, Carter, Fullaway, Illingworth, Pemberton, Rosa, Swezey and Williams.

PAPERS PRESENTED

Mr. A. C. Browne presented a paper entitled: "Insects taken at Light at Kalawahine Place, Honolulu."

Mr. O. H. Swezey presented papers entitled: "An Immigrant Tenebrionid Beetle new to Hawaii"; "Corrections in Use of the Name *Oechalia grisea* (Burm.) (Hem.)"; and "Some Corrections

in the Use of Names for the Species of *Nysius* in Hawaii. (Hem.)".

On behalf of Dr. R. L. Usinger, Mr. O. H. Swezey presented a paper entitled: "A New Species of *Oechalia* from Oahu (Hemiptera: Pentatomidae)."

NOTES AND EXHIBITIONS

Dr. J. F. Illingworth stated that he found *Musca domestica* more numerous this season in Kaimuki than before.

Dr. Walter Carter exhibited a photograph of two weeks exposure made with radio-active material of the feeding tracks of a mealybug. The radio-active phosphorus collected not in intestinal tract but in the mycetom area of the insect.

Mr. C. E. Pemberton exhibited *Sessinia livida* (Fab.) sent him by an army doctor from the South Pacific with the statement that the insect was capable of blistering if brushed off one's arm for example; the beetle is rather widespread in Polynesia to Fiji.

Mr. Pemberton also mentioned the interception in Honolulu on a bomber plane from the Pacific coast, of a living *Anopheles* sp. mosquito, and of two living *Diabrotica soror* beetles.

Mr. D. T. Fullaway spoke of his recent work on the mainland, chiefly in Michigan, on parasites of *Megamelus davisi* the leafhopper now occurring on *Nymphea* water lilies on Oahu.

DECEMBER 22, 1941

The 432nd meeting of the Hawaiian Entomological Society was held at the H.S.P.A. Experiment Station on Monday, December 22, at 2: 30 p.m., Vice-President O. H. Swezey presiding.

Members present: Messrs. Fullaway, Holdaway, Illingworth, Keck, Krauss, McBride, McPhail, Marlowe, Pemberton, Rosa, Sakimura, Swezey, Van Zwaluwenburg and Williams.

Mr. Swezey moved that in view of the short time at our disposal the reading of the minutes be dispensed with, save the treasurer's report.

The treasurer presented the financial report for the year ending December 3, 1941. It was moved, seconded and passed that this report be accepted subject to audit. Mr. Swezey appointed Mr. Fullaway as auditor.

The following officers were elected for 1942:

President	E. C. Zimmerman
Vice-President	O. H. Swezey
Secretary-Treasurer	Dr. F. X. Williams
Additional members of Executive Committee	D. T. Fullaway
	Dr. F. G. Holdaway

PAPERS PRESENTED

Dr. F. G. Holdaway presented a paper entitled: "Insects associated with freshly threshed dry beans".

On behalf of Dr. C. T. Brues, Mr. O. H. Swezey presented a paper entitled, "A Species of Phoridae bred in Hawaii from the Immigrant African Land Snail (*Achatina fulica*)".

Mr. O. H. Swezey presented a paper entitled: "Notes on food habits of Lepidoptera in Samoa".

Mr. D. T. Fullaway presented a paper entitled: "A list of Parasitic Hymenoptera collected by F. X. Williams in New Caledonia." Dr. F. X. Williams presented a paper entitled: "Ampulex Compressa (Fabr.) A Cockroach-Hunting Wasp Introduced from New Caledonia into Hawaii".

NOTES AND EXHIBITIONS

Mr. R. H. Van Zwaluwenburg mentioned the recovery on the Island of Maui, of *Baeus californicus* Pierce, hymenopterous egg parasite of the Black Widow spider, introduced from California.

Waterlily leafhopper egg-parasite.—Mr. Fullaway reported that the egg parasite of the waterlily leafhopper introduced from Michigan during the past summer, has become established here. Recoveries were made from leafhopper material collected from a Waikiki lily pond early this month. In the meantime, information has been received in regard to the identity of the species of *Megamelus* infesting our waterlilies. Mr. Oman, of the U.S. Bureau of Entomology and Plant Quarantine, has compared examples from here with typical material of *M. davisi* and states he is convinced they are different species—that our bug is identical with specimens in the national collection taken in Florida—possibly *M. angulatus,* or an undescribed species.

Anagrus frequens Perkins.—Mr. Swezey reported rearing this mymarid abundantly from eggs of the corn leafhopper (*Peregrinus maidis* (Ashm.)) in leaves of teosinte at the Experiment Station, H.S.P.A. grounds Nov. 25, 1941. Count was made of the leafhoppers hatching from a half dozen leaves, which was 136, and from the same leaves 113 parasites issued, a parasitism of 45%. This demonstrates that this egg-parasite still persists, although not particularly noticed of recent years. Slide mounts were exhibited.

Pachyneuron allograptae Ashm.—Mr. Swezey reported having reared this syrphid parasite from two syrphid puparia found on leaves of teosinte at the Experiment Station, H.S.P.A. grounds, Nov. 25, 1941. Ten parasites issued from one puparium, and 15 from the other one, a 100% parasitism.

Ephestia kuhniella Zeller.—Mr. Swezey exhibited a specimen of the Mediterranean flour moth which had emerged from a pupa found in a tin of "vacuum-packed" walnut halves from California, Dec. 3, 1941. A pair was taken from the same tin on Dec. 5.

Insects Taken at Light at Kalawahine Place, Honolulu

BY A. C. BROWNE
University of Hawaii.

(Presented at the meeting of November 10, 1941)

The insects of this list were taken at light on an open lanai, all on a single evening, October 28, 1941. They have been determined by O. H. Swezey.

ORTHOPTERA

Atractomorpha ambigua Bol. (Observed but not captured)

DERMAPTERA

Chelisoches morio (Fab.). (Observed but not captured)

BLATODEA

1. *Diploptera dytiscoides* (Serv.). Beetle roach

NEUROPTERA

1. *Chrysopa lanata* Banks. Green lacewing fly.

HEMIPTERA

4. *Geotomus pygmaeus* Dallas. A black bug.
13. *Orthoea nigriceps* (Dallas).
1. *Nysius dallasi* White.
1. *Clerada apicicornis* Sig. A predaceous bug.
3. *Pycnoderes quadrimaculatus* Guer. Bean pest.
1. *Hyalopeplus pellucidus* Stal. A plant bug.
1. *Cyrtopeltis varians* (Dist.). Tomato and bean pest.
1. *Leucopoecila albofasciata* Reut. Plant bug on grass.
6. *Peregrinus maidis* (Ashm.). Corn leafhopper.
4. *Draeculacephala minerva* Ball. Green sharpshooter jassid.

COLEOPTERA

Copris incertus prociduus Say. Mexican dung beetle. (Observed but not captured)
3. *Adoretus sinicus* Burm. Chinese rose beetle.
15. *Aphodius lividus* (Oliv.).
1. *Lacon modestus* (Boisd.).
2. *Ananca bicolor* (Fairm.).
8. *Gonocephalum seriatum* (Boisd.).
1. *Alphitobius diaperinus* (Panz.).
2. *Eutochia lateralis* (Boh.).
1. *Platydema obscurum* Sharp.

1. *Schistoceros cornutus* (Pallas). Dead wood borer.
1. *Xylothrips religiosa* (Boisd.). Dead wood borer.
3. *Sybra alternans* Wied. Dead wood borer.
1. *Prosopis bankii* (Fab.). Dead wood borer.
3. *Cylindera flava* (Fab.). Dead wood borer.
1. *Ceresium unicolor* (Fab.). Dead wood borer.
1. *Apomecyna pertigera* (Thoms.). Borer in cucurbitaceous vines.
2. *Lyphia angusta* (Lucas). (?) New immigrant, tentatively determined by Dr. F. E. Blaisdell.
2. *Bruchus prosopis* Lec. Bruchid in algaroba beans.
2. *Catorama pusilla* Sharp. Anobiid in pods of *Acacia farnesiana.*
3. *Coccotrypes dactyliperda* (Fab.). Scolytid in palm seeds.
8. *Oxydema fusiforme* Woll. Weevil in dead wood.

LEPIDOPTERA

3. *Laphygma exigua* (Hub.). Pest on several garden plants.
2. *Plusia chalcites* (Esp.). Garden pest.
1. *Nesamiptis plagiata* Meyr.
Erebus odora (Linn.). Black witch moth. (Observed but not captured)
1. *Scotorythra caryopis* Meyr. Koa moth.
4. *Hymenia recurvalis* (Fab.). Beet webworm.
1. *Maruca testulalis* (Geyer). Lima bean pod borer.
2. *Hellula undalis* (Fab.). Cabbage moth.
1. *Pyralis mauritialis* Boisd. Caterpillar infests wasp nests.
1. *Orneodes objurgatella* Walsm. Infests fruits of Plectronia.
18. *Stoeberhinus testaceus* Butl. Scavenger moth.
2. *Argyroploce illepida* (Butl.). Koa seed moth.
1. *Decadarchis simulans* (Butl.). Larva in dead bark and wood.
4. *Decadarchis minuscula* (Walsm.). Larva in old seed pods, etc.
3. *Hyposmocoma canella* Walsm.
1. *Hyposmocoma corvina* (Butl.).
2. *Bedellia orchilella* Busck. Sweet potato leafminer.
12. *Petrochroa dimorpha* Busck. Scavenger in sod, etc.

DIPTERA

2. *Neosciara* sp. Fungus gnat.
1. *Forcipomyia ingrami* Carter.
1. *Chironomus hawaiiensis* Grims.
11. *Styringomyia didyma* Grims.
1. *Limonia* (*Dicranomyia*) *casei* Alex. Cranefly.
1. *Scolastes bimaculatus* Hendel. Coconut fly.
1. *Leptocera* sp.

HYMENOPTERA

7. *Paratrechina sharpii* (Forel). Ant.
Polistes sp. Yellow jacket wasp. (Observed but not captured).

Rediscovery of *Leucospis antiqua* Walker in New Caledonia

BY CHARLES T. BRUES
Biological Laboratories, Harvard University.

(Presented by Dr. Williams at the meeting of July 14, 1941)

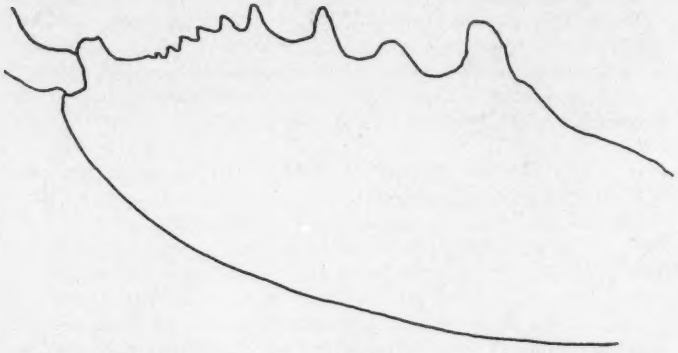
Among the exotic species of *Leucospis* described by Walker in 1860 (Journ. Entom., vol. 1, p. 19) is one from New Caledonia which has not since been recognized. Recently, Dr. F. X. Williams secured two specimens, both males, which agree perfectly with the description given by Walker, and are obviously his species. They were collected at Noumea, New Caledonia, Oct. 30 and Nov. 2, 1940.

It is now possible to indicate more clearly the relationships of this species to other members of the genus which is widely distributed in the Indomalayan Region.

The color pattern is well described by Walker; the narrow yellow band on the abdomen is on the posterior margin of the second tergite and there is also a very narrow yellow streak at the posterior margin of the third tergite, except at the sides. Joints of antennal flagellum all much longer than wide. Face punctate, confluently so, except at the middle above, the punctures fused into more or less regular vertical lines or striations. Eyes slightly sinuate, the width of the head about equal to its height; malar space one-fifth the length of the eye. Pronotum shorter than the mesonotum, with two transverse carinae before the hind margin, the basal one short, but very distinct, the posterior one half the width of the pronotum. Pronotal punctures very small and sparse in front; coarser, separate at the middle and confluent on the posterior half. Mesonotum and scutellum with moderately large separated punctures and a trace of transverse rugae near the middle of the mesonotum. Metanotum smooth, polished, its posterior margin deeply emarginate but not toothed at the hind angles. Propodeum with a complete median and a lateral carina on each side, without spine or protuberance. Abdominal petiole one-fifth longer than wide, the lateral margins strongly arcuate and the disc convex; following segment greatly narrowed at the base where it is narrower than the petiole and only one-third as wide as at apex. Dorsal sutures between the second and following tergites practically obsolete, upper surface coarsely, separately punctate; apex of carapace prolonged at each lateral angle as a long, sharp tooth between which the rounded apex of the abdomen projects. Hind femora each with a very large tooth at the middle, followed by a very short one; third and fourth longer, decreasing in size; fifth smaller; sixth and several more to

apex growing very minute; the whole femur unusually slender. Length 8-10 mm.

The abdominal petiole is unusually well set off from the gaster, with strongly bulging sides and is quite different in this respect from the condition usually prevailing in *Leucospis*. One other species, *L. muiri* Brues, from Laloki, Papua, shows a tendency in this direction in the male, but the sides are much more nearly parallel.



Dentition of hind femur of *Leucospis antiqua* Walker, ♂. Highly enlarged.

On account of the unusual shape of the abdomen the male of *Leucospis antiqua* resembles in a very striking way a vespid wasp, a resemblance which is heightened by the color pattern. The wasp, which is also practically of the same size of the *Leucospis* has been identified by Professor Joseph Bequaert as *Pachymenes quodi* (Vachal).

A Species of Phoridae Bred in Hawaii From the Immigrant African Land Snail (Achatina Fulica)

BY CHARLES T. BRUES
Biological Laboratories, Harvard University.

(Presented by Mr. Swezey at the meeting of December 22, 1941)

In various parts of the world there are numerous species of small flies of the family Phoridae that have been found associated with terrestrial gastropod mollusks. The majority of these undoubtedly develop in snails already dead from some other cause; some probably occur in the slimy exudate of living hosts, and there is reason

to suspect, but without conclusive proof, that some may be true internal parasites of living snails. Mr. E. H. Bryan, Jr., sent me recently four specimens of a very small, winged species that were bred by one of his associates at B. P. Bishop Museum, Yoshio Kondo, from a dead example of the large African snail, *Achatina fulica*. After a careful examination of four specimens, including both sexes, it appears that this phorid is undoubtedly undescribed. It is quite similar to the European *Megaselia pygmaea*, known to occur also in a number of widely separated regions, but is obviously distinct. A further search to identify it with any other species of this large, cosmopolitan genus has failed, and though there is a very considerable chance that its original provenience is not Hawaii, it seems appropriate to describe it at this time since we know something of its habits and structurally it is easily identified.

Megaselia (*s. str.*) **biformis** sp. nov.

♀. Length 1.4 mm. Black, with the thorax reddish brown above and distinctly lighter on the pleurae and coxae; abdomen with the basal four tergites rather broadly margined with yellowish white behind. Legs testaceous or luteous; hind femora black at apex and their tibiae blackened at the extreme tip. Antennae reddish brown; palpi light yellow. Front approximately as high as wide; four postantennal bristles of equal size, those of the upper pair twice as far apart as those of the lower pair; antial bristles midway between the upper postantennals and the eye-margin, well below the lowest lateral bristle which is close to the eye; middle row of frontal bristles equidistant, the median pair higher than the lateral ones and twice as far from the upper postantennals as from the ocellar bristles. Surface not shining, glaucous. Antennae small, with weakly pubescent arista; palpi small, with moderately strong bristles. Propleura with a bristle at its upper angle, another next to the coxa and a scattering series of much weaker ones along the hind margin between those. Mesonotum moderately shining, with a single pair of dorsocentral bristles. Scutellum with four large marginal bristles. Mesopleura entirely bare. Abdominal tergites fully formed, none of them narrowed, the second without any bristly hairs at the sides; second to fifth of approximately equal length, their posterior margins practically straight, except the fifth which is broadly rounded. Middle and hind tibiae with a single row of bristles lying inside the hairseam; those of the middle pair weak; those of the hind tibiae very weak on the basal third but longer beyond where their length is equal to two-thirds the width of the tibia. Wings rather long and narrow; costa distinctly less than one-third the wing length (17 : 57), its fringe short at the base, but much longer toward apex where the bristles are as long as the second vein. First section of costa twice as long as the second and third combined, the third section very short as the cell between the second and third veins is extremely minute; fourth vein curved upwards at its apical third, but nearly straight elsewhere, fifth vein indistinctly sinuate, almost straight; sixth more clearly sinuate; sixth vein distinct. Halteres pale yellow.

♂. Similar to the female, but somewhat darker in color, especially the antennae. Scutellum with only two bristles, the lateral pair reduced to extremely minute hairs. Wings somewhat broader. Costa exactly one-third as long as the wing (15 : 45); first section slightly less than twice as long as the second and third combined.

Type and three paratypes (two females and one male) from Honolulu, Hawaii, February, 1941, reared from a dead specimen of *Achatina fulica* (Y. Kondo).

There are a few species of *Megaselia* in which the female possesses four large scutellar bristles while the male has the anterior pair reduced to small hairs. None of the forms of this type where both sexes are known resemble the present species at all closely in other characters. Aside from this peculiarity *M. biformis* differs from *M. pygmaea* Zett. by the equal postantennal bristles and by the wide, completely formed abdominal tergites, which also serve to distinguish it from *M. latericia* Schmitz. The European *M. pygmaeoides* Lundb. likewise differs by its unequal postantennal bristles as well as in the length of the costal vein. From *M. angustiata* Schmitz from the Canary Islands it is distinct by the equally strong postantennal bristles and much shorter costal vein. The pale halteres serve to distinguish it from several other species with very short costal vein. Several other forms associated with mollusks, like the African *M. michaelis* Schmitz, are structurally not at all similar and the same is true of *M. curtineura* Brues from the Philippines which is superficially similar on account of its short costal vein. The last species was found breeding in culture media which were presumably contaminated with fungi or bacteria.

Senior-White has described *Megaselia achatinae* (Spolia Zeylanica, vol. 12, p. 401 (1924)) as bred from a dead Achatina snail from Ceylon. Unfortunately his description is utterly inadequate to place the species, although from the size and color it may be the ubiquitous *M. xanthina* Speiser which is widerspread and abundant in this region.

On the Making of Genitalia Slides of Lepidoptera

BY AUGUST BUSCK
U. S. Bureau of Entomology and Plant Quarantine, Washington, D. C.

(Presented at the meeting of February 10, 1941)

The value of the study of the genitalia of both sexes in the classification of Lepidoptera is so generally accepted as to require no further arguments. The "fingerprints" are here to stay as an essential part of the study of Lepidoptera (and most other insects); no modern Lepidopterist can afford to neglect them.

The nomenclature of the different parts has been repeatedly given and is happily used reasonably uniformly by Lepidopterists, with only minor variations of some of the terms.[1] Several coworkers, among others your own beloved Otto H. Swezey, have asked for short directions on the technic of making these preparations and this is all that is attempted in the present note.

It may, however, be convenient for the student to recapitulate shortly the terms used for the different parts of both sexes and this may easiest be done by referring to the accompanying figures and the lettering on them.

The male genitalia proper consist of the ninth and tenth abdominal segments and their appendages. In several groups the eighth abdominal segment is also more or less modified and secondarily a part of the genital structure, serving as a covering or exhibiting scale tufts, which undoubtedly play a role in the sexual act.

On the 10th segment the *uncus* (U) may be considered the tergite and the *gnathos* (Gn) the sternite with the *socii* (Si), when present, arising at the base of the uncus; between these terminates the alimentary canal in the anal opening.

The *uncus* is of various form, joined by a membrane to or fused with the tergite of the ninth segment, the *tegumen* (Tg). It may be spoon-shaped or hooklike, smooth or hairy, bifurcate or trifid; in many forms it is much reduced or absent.

The *socii* (Si) are paired organs, arising from the base of the uncus above the gnathos; normally soft and hairy; they may be erect or drooping, cylindrical or flattened; rarely strongly sclerotized; often absent.

The *gnathos* (Gn) is a paired organ, consisting of two arms, arising at the base of the uncus and normally fused at their tips into

[1] The several valuable volumes of illustrations of these structures by F. N. Pierce and Rev. J. W. Metcalfe should be referred to on these subjects. Carl Heinrich's and Busck's short paper on the male genitalia (Proc. Ent. Soc. Wash., Vol. 23, pp. 145-152, pls. 12-13, 1921); Busck: On the Female Genitalia of Microlepidoptera (Bull. Brooklyn Ent. Soc., 26, pp. 199-216, 5 pls., [1931] 1932); as well as W. T. M. Forbes: "Lepidoptera of New York" will also be helpful and accessible to American workers.

a strong hook; but in some families the arms are free and more or less fused with the socii (Sparganotidae). In some families the gnathos is supplanted by a ventral plate (Vp) in the median line below the alimentary canal; the plate may be a broad shield (*Peronea*) or a slender sclerotized rod along the underside of and supporting the alimentary canal (Aegeriidae). The gnathos probably functions as a check on the flow of the content in the alimentary canal; it may be entirely absent (Phalonidae) and its function may then be taken over by a strongly developed *transtilla* (Ts) of the ninth segment.

The ninth segment consists of a large tergite, the *tegumen* (Tg), which forms the back of the genitalia structure and the sternite, the *vinculum* (Vm) of various forms, from a thin ring to a broad shield often with a long pointed prolongation; behind the vinculum is normally found a small, more or less triangular plate, the *anellus* (An) which supports the *aedoeagus* (Ae). Articulated on the vinculum and often also attached to the anellus, are the paired, lateral, more or less wing-shaped clasping organs, the *harpes* (Hp).[2]

The *harpes* are modified pedal appendages of the ninth segment, the joints of which are sometimes defined by actual sutures (Ethmiidae). More often these sclerotized segments are completely fused, but three areas may normally be differentiated by heavier sclerotizations or different armature or scaling, the *costa* (Ca), the *sacculus* (Sc), and the *cucullus* (Cs). These parts are together or separately modified in various ways; the *costa* and the *sacculus* are sometimes developed into free arms, so as to result in double harpes.

The *transtilla* (Ts) in its simplest form is a narrow band connecting the two harpes at their inner costal angles. In some families it is strongly sclerotized and armed at its ends or in its middle with heavy thorns or hooks. In other forms it is attenuated or broken in the middle or reduced to short arms or knobs from the base of the harpes.

The *aedoeagus* (Ae) is a more or less strongly sclerotized tube, which contains and protects the delicate membranous *penis* (P). It may be straight or curved and is often prolonged into one or more spines at the tip and or laterally armed with sharp teeth or other processes. At the base it is commonly bulging out into a blind oval or ball-shaped sack below the entrance hole of the penis. In the higher groups the aedoeagus is normally articulated on the anellus; in the lower it is merely supported by the membrane of the ninth segment, which sometimes forms a tube around it.

Inside the aedoeagus lies the soft flexible *penis* (P), which by blood pressure during copulation is projected far beyond the mouth

[2] The *valvae* of Pierce. Others have used the term clasper for these organs, but that term was first used by J. B. Smith for thorn-like projections from the sacculus, strongly developed in the Noctuidae, with which Smith worked.

of the aedoeagus through the ductus and into the bursa of the female. The penis is often armed with one or several short or long spines, the *cornuti* (Cn) or "love-thorns". These may be permanently attached on the penis or may be deciduous and remain in the bursa of the female after copulation.

In most Lepidoptera the male genital structures are symmetrical, with right and left sides alike, but asymmetry is met with in several groups and is characteristic of entire families (Crambidae, Cosmopterygidae); in such cases there is normally similar asymmetry in the female organs, enabling copulation from only one side.

The female genitalia (in the most numerous main groups of Lepidoptera with two genital openings, one for copulation and one for egg-laying) terminate normally in a pair of flattened hairy lobes, the *ovipositor* (Ov), between which lies the anus and the end of the egg duct. The ovipositor, however, in many Lepidoptera is variously modified, often telescopic for the deposition of the eggs in deep crevices or strongly sclerotized for cutting purposes.

On the underside of the eighth abdominal segment or in the connecting tissue between the eighth and the seventh segment is found the second genital opening, the *ostium* (Os) through which copulation takes place. The ostium is generally surrounded by a more or less defined *genital plate* (G. P.) and leads into the *ductus bursae* (D) which connects it with the *bursa copulatrix* (B) where the male sperma is deposited. The *bursa* is commonly armed on the inside with one or more sclerotized plates or thorns, the *signum* (S), which, when present, offers excellent characters for classification. In many species, however, it is absent. The *ductus* is normally a simple short tube, but in some groups it is very long—sometimes twice as long as the abdomen and therefore bent upon itself or spiraled and in such cases often strengthened by sclerotization.

In the other, more primitive, smaller main group of Lepidoptera with only one sex opening at the tip of the abdomen the *ostium* is lacking but the *ductus* and the *bursa* with or without its *signum* are present.

The technic in the preparation of these sex organs for microscopic study is very simple and can be acquired by anyone with good eyes and nimble fingers with a few hours' practice.

First (1) write your labels, one for the specimen stating merely: ♂ (or ♀) genitalia on slide number ....., date and the maker's initials; the other label—to be eventually copied on the slide when finished—*giving the same data as above and the full date and locality data, collector, host plant, etc., as found on the specimen.* In this way it is always possible to connect the specimen and the slide.

(2) Detach the abdomen. This can normally be done easily by lifting it upwards with a stiff needle; avoid a springy pin, as the

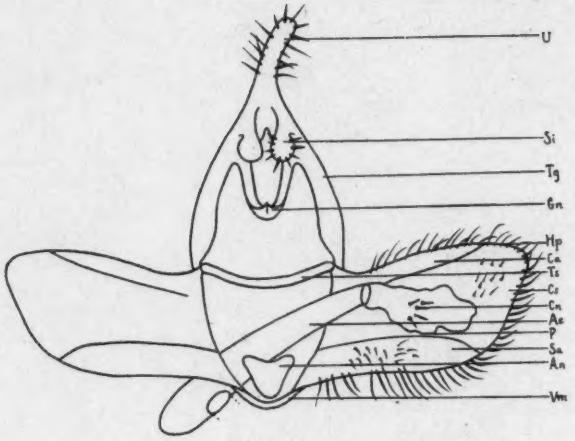


Fig. 1.

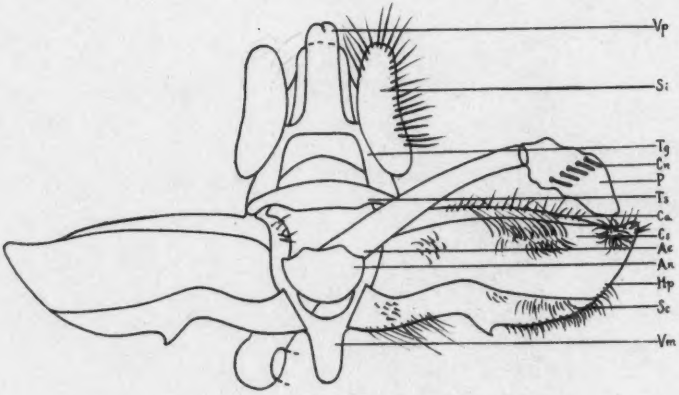


Fig. 2.

Male genitalia of Lepidoptera. Diagrammatic.

abdomen, if small, is apt to jump and get lost. Avoid especially a glued on abdomen, which may or may not truly belong to the specimen and which therefore may lead to very disastrous conclusions.

(3) Drop detached abdomen for a minute in alcohol until saturated.

(4) Drop abdomen into a small vial with a nearly saturated water solution of Potassium Hydroxide (KOH) and pin your temporary label firmly to the cork. Several vials may conveniently be kept upright in a rack.

(5) Leave small abdomens in the cold KOH until the next day; large fatty abdomens may require a longer time.

(6) Place the now soft abdomen in clean water in a small glass or porcelain dish and clean out the inside of the abdomen by *gentle* pressures with a small *soft* camel hair brush.

(7) Place the then empty skin in water on a slide and finish cleaning under the microscope. Manipulate with two fine micro pins firmly stuck into handles, preferably somewhat obliquely. Separate the male genitalia from the rest of the abdomen by inserting one pin just under the edge of the tegumen, holding the rest of the abdomen with the other pin. If the specimen is in the right condition, this is easily accomplished and the genitalia will come off with clean edges. Be careful that the *aedoeagus* comes out with the genitalia; it sometimes has a tendency to be retained in the abdomen. Still using your fine pins in holders endeavor to open the *harpes*, so as to obtain a full face view of the inside of the structure. With most Lepidoptera this can be done easily; but in some families (Gelechiidae) the short *transtilla* or other characteristics of the structure prevent the opening of the *harpes* without breaking or dislocating parts of the structure. In such cases the mount should be made for a lateral view. If the specimen is small, color it (not too strongly!) with a drop of Mercurichrome in the water on the slide.

(8) Dehydrate the abdomen and genitalia thoroughly in 95 per cent alcohol. This hardens and stiffens the genitalia somewhat, but they may still be manipulated carefully with the two micro pins and brought into the desired spread-out position.

(9) Lift genitalia and abdominal skin with your micro pin and place on a slide in a drop of oil of cloves for clearing. Keep the label with the slide. The genitalia may with advantage remain in the oil of cloves for an hour or even a day, but they become brittle and must then be handled with care.

(10) Drop into Xylol to remove the oil; the specimens are then ready to be mounted in balsam. Place on a clean slide, cover with a suitable drop or more of Canada balsam and place the cover glass on it, first wetting the underside with Xylol to avoid bubbles in the

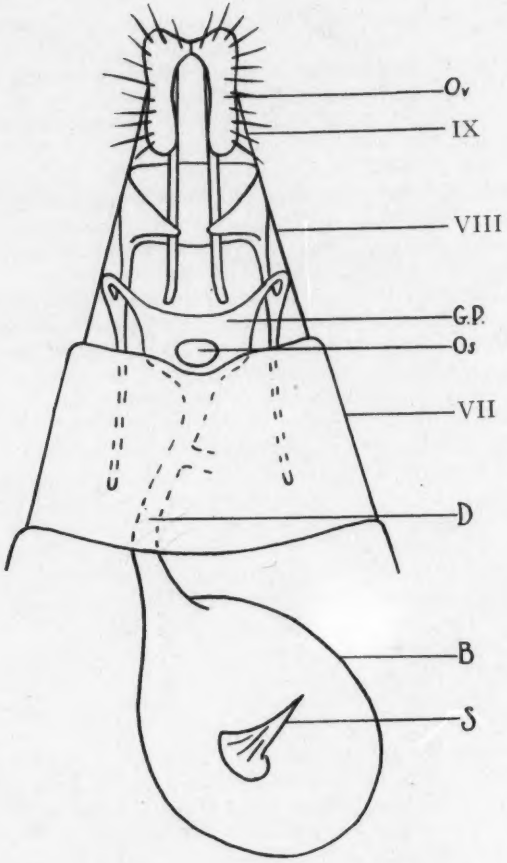


Fig. 3.

Female genitalia of Lepidoptera. Diagrammatic.

balsam. Use a rather thin balsam diluted with Xylol. If the specimen is large, use a drop slide.

(11) *Label—giving all the data.*

(12) The female genitalia require a somewhat different treatment in order to have the internal parts exposed. When they are in the water on a slide as in (7), tear the abdominal skin in two between the seventh and the sixth segments with your micro pins, using care not to cut the *ductus bursae,* pull it and the bursa out intact, connected with the anal segment. Otherwise proceed as with the male.

With large moths and butterflies like the *Sphingidae* where it is desirable to retain the abdomen on the specimen and where the abdominal skin is too large for an ordinary slide, the genitalia can be picked out after the specimen is thoroughly relaxed.

The schematic drawings illustrating these notes were made by Miss Bernice Harper of the Bernice P. Bishop Museum staff and I wish to express my thanks to her for this and other kind help to me during my stay in Honolulu.

EXPLANATION OF FIGURES

FIG. 1. Hypothetical male genitalia of a Lepidopteron with gnathos present.

FIG. 2. Hypothetical male genitalia of Lepidopteron with gnathos absent, supplanted by a ventral plate.

FIG. 3. Hypothetical female genitalia of Lepidopteron with two sex openings.

Figures 1 and 2, male

Ae—aedoeagus
An—anellus
Ca—costa
Cn—cornuti
Cs—cucullus
Gn—gnathos
Hp—harpes
Sc—sacculus
Si—socii
Tg—tegumen
Ts—transtilla
U—uncus
Vm—vinculum
Vp—ventral plate

In figure 3, female

VII—Seventh segment
VIII—Eighth segment
IX—Ninth segment
B—bursa copulatrix
D—ductus bursae
G.P.—genital plate
Os—ostium
Ov—ovipositor
S—signum

A New Species of Trixagus From the Hawaiian Islands (Coleoptera: Trixagidae)

BY W. S. FISHER
Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

(Presented by Mr. Van Zwaluwenburg at the meeting of March 10, 1941)

At the October meeting of the Hawaiian Entomological Society (Haw. Ent. Soc. Proc. 3 (1916) 1917, p. 289) Mr. Bridwell exhibited a specimen of *Throscus* sp. collected at light, and at the November meeting (Haw. Ent. Soc. Proc. 3 (1916) 1917, p. 291) Messrs. Giffard and Timberlake reported taking the same species of beetle at the Pali, and Mr. Swezey reported having taken it at light.

The specimens described below were received for identification from R. H. Van Zwaluwenburg, and had been sent to G. E. Bryant at the British Museum, who reported that the species was not represented in that museum. This is the first species of the family Trixagidae to be described from the Hawaiian Islands.

This genus is listed in the literature as *Throscus* Latreille in the family Throscidae, but *Trixagus* Kugelann has priority.

Trixagus extraneus, new species

Male.—Elongate oval, slightly narrowed posteriorly, uniformly dark reddish brown, with the antennae slightly paler, rather densely, uniformly clothed with fine, recumbent and coarse, semierect, yellowish-white hairs, the semierect hairs on the elytra forming more or less longitudinal rows.

Head strongly convex, with two short, slightly elevated, longitudinal carinae near the antennal cavities, the carinae diverging toward clypeus; surface finely, densely, shallowly punctate. Eyes slightly convex, each divided by a rather broad, deep impression, and the eyes separated from each other on the front by a little more than their diameter, and not differing in the two sexes. Antenna pubescent, with the club broad, somewhat contractile, and equal in length to segments 1 to 8 united; segment 1 broad, slightly flattened; segment 2 broad, cylindrical; segments 3 to 8 much narrower and shorter than 2, and subequal to each other in width and length; segment 9 broadly triangular; segment 10 narrow and strongly transverse; and segment 11 elongate triangular, and acuminate at apex.

Pronotum slightly convex, nearly twice as wide as long, distinctly narrower at apex than at base, faintly, transversely depressed along base, the posterior angles finely carinate, prolonged, and embracing the base of the elytra; sides strongly, arcuately diverging from apical angles to near posterior angles; surface shallowly, uniformly but not closely punctate, the intervals indistinctly granulose. Scutellum elongate triangular.

Elytra finely striate, the striae finely but not closely punctate, the intervals indistinctly granulose, each with two irregular rows of rather large, shallow punctures.

Abdomen beneath densely, indistinctly granulose, sparsely, coarsely, shallowly punctate; prosternum with the lateral striae entire, the striae parallel

posteriorly and slightly divergent anteriorly, the surface sparsely, coarsely punctate.

Female.—Differs from the male in having the antennal club much narrower, and equal in length to the first five segments united.

Length 2.25-2.5 mm., width 0.9-1 mm.

Type locality.—Kaimuki, Oahu, Hawaii.

Type and allotype.—In the United States National Museum, No. 54981. *Paratypes.*—In the type collection of the Experiment Station, H.S.P.A., Honolulu.

Described from four specimens (one male type). The type was collected at light in a house at the type locality, October 29, 1920, by P. H. Timberlake; the allotype was collected at light in Manoa Valley, Oahu, August 6, 1933, by R. H. Van Zwaluwenburg; one male paratype was collected on a window of the entomological laboratory at Honolulu, February 1, 1924, by O. H. Swezey; and one female paratype, from the collection of O. H. Swezey, was collected at light at the type locality, October 17, 1916.

This species is allied to *Throscus chevrolati* (Bonvouloir), but differs from that species in being more strongly narrowed posteriorly, in having the antennae differing in the two sexes, and, in the male, in not having a fringe of pale hairs at the sides of the elytra.

Insects Associated With Freshly Threshed Dry Beans

BY DR. F. G. HOLDAWAY AND MR. T. NISHIDA
University of Hawaii.

(Presented at the meeting of December 22, 1941)

Dr. F. G. Holdaway and Mr. T. Nishida contributed the following information on insects associated with freshly threshed dry beans. The beans were grown at Ewa Plantation in an Emergency pilot planting. They were harvested and threshed at the end of September 1941.

THRESHINGS FROM THE THRESHER SCREEN—1½ LBS.

The threshings contained plant debris and a few broken and sound beans of Blackeye cowpea.

Insects recovered

Coleoptera
- Bruchidae
  - 19 *Bruchus quadrimaculatus* Fabricius
  - 2 *Callosobruchus chinensis* (Linn.)
  - 1 *Acanthoscelides obtectus* (Say)
- Bostrychidae
  - 10 *Sinoxylon conigerum* Gerst.
- Anthribidae
  - 2 *Areocerus* sp.
- Nitidulidae
  - 6 *Carpophilus dimidiatus* (Fab.)

Hemiptera
- Cydnidae
  - 1 *Geotomus pygmaeus* Dallas

Twenty of the twenty-two beans found in the debris had eggs of *B. quadrimaculatus* attached. The number of eggs per bean ranged from one to five; one bean, however, bore seventy-eight eggs.

BLACKEYE COWPEA BEANS FROM THE THRESHER—3 1/10 OZS.

The total number of beans in the sample was 436. Twenty-five percent bore eggs, either 1, 2 or 3 per bean, averaging 40 eggs per 100 beans. The number of adult beetles which emerged from the sample is given below; the beetles were removed as they emerged.

Species	No.
Bruchus quadrimaculatus	115
Callosobruchus chinensis	3

If the beetles had not been removed as they emerged, the beans would undoubtedly have been ruined in due course.

LIMA BEANS (VARIETY UNKNOWN)

No insects were recovered from the lima beans.

These observations indicate the following points:

1. Blackeye cowpea is highly susceptible to attack by *Bruchus quadrimaculatus*.
2. The trash contains large numbers of the adult.
3. Initial infestation occurs in the field before the beans are harvested.
4. Lack of recognition of the injury likely to occur to Blackeye cowpea from bruchids could result in the complete destruction of the harvested crop.

An Outbreak of Cockroaches, Nauphoeta cinerea (Olivier), in Honolulu

BY J. F. ILLINGWORTH

(Presented at the meeting of January 13, 1941)

Nauphoeta cinerea (Olivier)

1789 *Blatta cinerea* Olivier, Encycl. Method., Ins., IV, p. 314. Adults and juv., L'lle de France (Mauritius).

1899 *Nauphoeta bivittata* Burm.

Fauna Hawaiiensis, Vol. II, p. 7.

"Hab. Two examples taken under bark of trees in Honolulu."

1922 *Nauphoeta cinerea* (Olivier)

Dermaptera and Orthoptera of Hawaii, Morgan Hebard, Occasional Papers, Bishop Museum, Vol. VII, No. 14, p. 335.

1920 *Nauphoeta cinerea* (Ol.)

Cockroaches as Greenhouse Pests. Garten-flora (Berlin) No. 13-14, pp. 165-168, 2 figs. "Observed in London . . . has reached Hamburg from East Africa."

1924 *Nauphoeta cinerea* (Ol.)

Nova Caledonia, Zool., Vol. III, L. II, p. 335, 1 ♂ (A. Fauvel, 1910). (Museum Paris.)

These roaches, which have heretofore been considered rather rare in Hawaii, recently developed in alarming numbers in and about the feed room of the poultry plant at the University of Hawaii. I have made observations on this species for many years, dating as far back as January 1914, and as there appears to be little on record as to their habits, this paper has been prepared.

Distribution: This is distinctively a circumtropical roach. Following its discovery in Mauritius (1789), I find evidence that it extends right around the world. I collected it in Townsville, North Queensland, in 1921, where it was an abundant pest about the buildings used for breeding experimental animals for the medical investigation. Published records include New Caledonia, Hawaii, Galapagos Islands, Brazil, East Africa, and in heated buildings, even to England and Germany.

In January, 1914, I found this species rather abundant in Camp rubbish out along Waialae beach, east of Honolulu. A favorite hiding place was in old weather worn shoes. I then collected numerous specimens and kept them for many months under observation at the College of Hawaii, making notes.

Life history and habits: I found that this species normally retains the eggs within the body until they are hatched, thus giving

birth to living young. By dissecting gravid females, I found that the eggs are packed side by side in a double row, forming an ootheca-like mass. These masses contain from 28 to 40 eggs or young, and they are covered with a delicate, transparent membrane. June 1, 1914, I observed a female with the egg mass about one half extended from the end of the body. It was white and was without any covering. The young roaches forming it could be seen distinctly, packed very closely together along each side. As they separated from this ootheca-like mass they were seen to be compressed laterally, but after a period of 2 to 3 hours they developed the normal dark coloring and assumed a roach-like appearance, with dorso-ventral flattening.

Roaches confined, after several months produced only aborted egg-masses, which they extruded, but these soon dried up because they were unprotected from the air.

I found that this species is very predacious, killing and eating cypress roaches, *Diploptera dytiscoides* (Serville), and even devouring their own dead. They are also omnivorous feeders, eating bits of soaked bread, raw potatoes, and various fruits. Recently, I learned that they are very fond of, and gorge themselves upon the balanced poultry feeds, containing fish oil, etc. With this feed abundant at the University farm, they multiplied in alarming numbers—literally by the bushel—as we found when we swept up after the war that was waged on them.

Control Measures: September 20, 1914, I discovered that ants, *Pheidole megacephala* (Fabr.) found their way into the breeding cage, where about 30 of these roaches were confined, and destroyed them completely within 24 hours. The ants first attack the legs in great numbers, eating through the soft membranes at the sutures. After they removed the legs the ants continued on the bodies until all parts were finally broken up, so that they could be carried down through a tiny hole in the floor, through which the ants had gained an entrance.

Experiments with sodium fluoride demonstrated that this chemical is very effective in destroying this species, as is the case with other large roaches. The insects do not relish the poison, but get it while preening themselves. Fearing that the hens would get the poisoned roaches prohibited this method of control. As an alternative, all portions of the infested buildings were sprayed with a combination of carbolic acid and a light poultry oil. While there was some risk from fire, and the sprayed rooms were messy for a while, the treatment killed all roaches hit. Dead specimens were so abundant on the floor after spraying that they were swept up by buckets full. Though roaches continue to appear from out-of-the-way places, not reached by the spray, this treatment gave them a real set-back.

Seasonal Trend in the Development of the Sex Forms of the Fire Ant, Solenopsis Geminata (Fabr.) var. Rufa (Jerdon), in the Pineapple Fields of Oahu[1]

BY K. ITO
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(Presented at the meeting of October 13, 1941)

Although the distribution of the fire ant is not limited to pineapple fields but extends into sugar cane fields as well along the dry coastal regions of Oahu, the data herein reported have been collected solely from the first-mentioned area. They are the result of systematic surveys conducted over a period of two years to establish the time and duration in the occurrence of sex forms of the fire ant in pineapple fields.

The fields in which the surveys were made were distributed from Sanitarium Flats on the one end to Waialua on the other. Fields in the Kunia, Kipapa, Kemoo, Brodie and Helemano sections were also checked. Most of these fields were in ratoon although a few were examined during plant crop. Moreover, in some cases, the surveys were continued even after the pineapple plants had been knocked down for fallowing. Wherever possible, contiguous new fields were substituted for those disced down during the survey period. Throughout the 2-year period, from 11 to 15 representative fields were examined during each survey.

The surveys were made at 2-month intervals. At the end of the first year the periodicity of the surveys was slightly altered so that the surveys would fall on those months in which none had been previously made.

SURVEY METHOD

The nests along the field roads were examined for the presence of sex forms, either in the immature stages as larvae and pupae or in the adult stage as alate males and females. Precautions were taken to avoid undue disturbance of the nests resulting from too frequent disruptions, by alternately examining the roads, so that nests along any one road would be surveyed only once in six months, but due to the encroachment of *Pheidole* ants which gradually decreased the number of fire ant nests and the fact that some of the fields were too small to have enough roads to practice alternate examinations, the scheme was not strictly adhered to.

The presence or absence of the sex forms in a nest was determined by digging up the nest and examining its contents. The pro-

[1] Published with the approval of the Acting Director as Technical Paper No. 138 of the Pineapple Research Institute of Hawaii, University of Hawaii.

cedure was simple during the wet fall to spring months when the immature stages were mostly confined to the surface and could be easily exposed with a scrape or a few thrusts of a shovel, but during the dry summer months, when they were being brooded at a depth of a foot or more beneath the surface, which had become compacted by the traversing of the heavy harvest trucks, real pick and shovel work was necessary to make the required examinations.

POPULATION TRENDS AND COLONY LIFE HISTORY

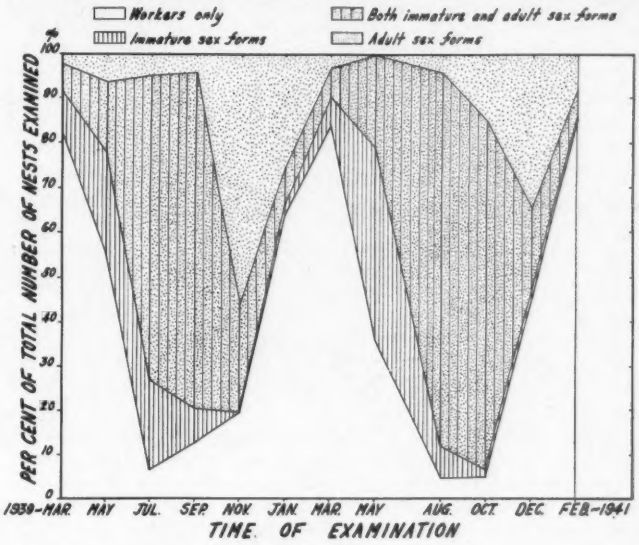
Since, with few exceptions, the general trends of population development in the fields in the different localities for any particular survey were found to be about the same, all the data have been analyzed collectively and set forth in Table 1 and graphically depicted in Fig. 1. The data obtained from the plant crop fields presented some slight exceptions to the general trend. Here, the majority of the nests found prior to harvest were small, many of them appeared to be incipient; but after the fruits had been picked and the field cleared for ratooning, the number and size of the nests along the roads not only increased but most of them contained mature as well as immature sex forms. This reaction would indicate that many of the colonies had been developing within the field blocks and had subsequently moved out into the roads only after the plant crop had been harvested. Due to this erratic behavior, all the records of examination made in plant crop fields were excluded from the analysis of Table 1.

TABLE 1.

A summary of survey data to determine the status of fire ant nests in regard to the presence of sex forms throughout the infested pineapple areas of Oahu from March 1939 to February 1941

Time of Survey	Total No. of Fields Surveyed	Total No. of Nests Examined	Nests with Immature Forms of Wkrs. Only		Nests with Immature Forms of Wkr. & Sex		Nests with Sex Forms in Addition to Worker Forms Imm. & Adult		Nests with Sex Forms in Addition to Worker Forms Adult Only	
			No.	%	No.	%	No.	%	No.	%
1939										
Mar.	12	409	337	82.40	38	9.29	25	6.11	9	2.20
May	12	494	272	55.06	113	22.87	79	15.99	30	6.07
July	11	354	24	6.78	72	20.34	241	68.08	17	4.80
Sept.	14	686	88	12.83	53	7.73	515	75.07	30	4.37
Nov.	10	439	86	19.59	0	0	106	24.15	247	56.26
1940										
Jan.	11	482	308	63.90	11	2.28	40	8.30	123	25.52
Mar.	10	576	483	83.85	36	6.25	38	6.60	19	3.30
May	10	512	185	36.13	220	42.97	106	20.70	1	0.20
Aug.	13	585	28	4.79	42	7.18	490	83.76	25	4.27
Oct.	14	490	25	5.10	7	1.43	382	77.96	76	15.51
Dec.	11	677	305	45.05	13	1.92	125	18.46	234	34.56
1941										
Feb.	12	743	631	84.93	6	0.81	45	6.06	61	8.21

Fig. 1- SEASONAL TREND IN THE DEVELOPMENT OF SEX FORMS OF FIRE ANTS IN THE PINEAPPLE FIELDS OF OAHU



Following the discing down of the pineapple plants, the nests along the field roads rapidly dissipated so that after the second discing, only a few weak nests remained. The large heaps of dead ant debris indicated death of most of the ants. In the wetland fields, *Pheidole* ants were scattered and became dominant after the plants were disced down.

Nests containing adult sex forms apparently exist throughout the year but they seem to reach a low level during the months from February to May and a peak during October or November. This trend has been shown in wind trap records previously reported (Proc. Haw. Ent. Soc., X, No. 3, pp. 429-435, Aug. 1940), but most of the individuals caught were males. It is during these peak months that dissemination of males and females and initiation of new colonies occur most extensively. It is also during this time that dissociation of the nests takes place, resulting in nearby heaps of dead ant debris.

The phenomenon of fire ant flights has been observed under both laboratory and field conditions to occur almost precisely at sunset. Unlike *Pheidole* ant flights which appear in great swarms and most noticeably in the mornings after heavy rains, fire ant flights pre-

sumably take place every night during the season of sex maturity with only a comparatively few individuals flying off from a single nest at any one time. Although both males and females fly away, there apparently is no such thing as a nuptial flight. Probably mating takes place within the nest and flight is primarily for dissemination.

The behavior of a colony preparatory to flight presents an interesting scene. Activity in the nest generally begins from about a half hour prior to sundown, when the winged sex forms gradually start to come out of the nest. The excitement is mainly confined to the winged forms which run about and spread themselves on the surface of the ground or clamber up nearby pineapple plants, weeds or trash. By sunset, the commotion ceases except for the few individuals which are limbering up their wings for flight. Flight begins immediately after sunset and continues for about an hour to an hour and a half, a few individuals flying off from time to time. Despite the excitement and the presence of both sexes, mating does not take place at this time. Only a small fraction of the total number of individuals present actually flies away; the rest slowly return into the nest after dark.

It has been observed that dealate females or queens were most common and easily found on the surface of the ground under the harvest trash during the fall months. As the peak of sexual maturity and flight of this ant usually coincide with the preparation and planting of new fields, such fields afford ideal conditions for those queens which happen to fly into them. Since it has been demonstrated that a solitary queen can initiate a colony of micrergates, it is conceivable that new colonies can be founded without much difficulty within a newly planted field even if previous infestations had been eliminated prior to planting. That this seems to be the case is shown by the fact that despite the eventual domination of the weedy wetland ratoon fields by *Pheidole* ants, these fields are found to have become reinfested with fire ants soon after the planting of a new crop of pineapple.

As has been noted before, the immature forms of the fire ant are brought to the surface of the nests during the wet months but are kept down at the moist depth of from 8 inches to a foot or more during the dry months. This reaction seems to be one primarily involving moisture as the young are brought to the surface following a soaking rain even during the summer or kept at a depth during a dry winter such as has been the case during the last year.

The nests were most frequently established either in the middle or at the ends of the beds along the north side of the roads when the beds ran in a north-south direction and in the middle or along the east side when the beds ran east and west. Though exceptions were numerous, it was often realized that the nests had been spaced at almost regular intervals of 10 beds, or about 60 feet apart. In the

wetland areas where the *Pheidole* ant invasion into the fields from the periphery was fairly rapid, situations were encountered every now and then where a few fire ant colonies had become isolated from their centrally occupied territory by the advancing *Pheidole* ants. Nevertheless, in general, the fire ants were able to maintain their ground even through the second ratoon period or probably longer if the field roads remained open.

SUMMARY

The developmental trend of the sex forms of the fire ant, *Solenopsis geminata* (Fabr.) var. *rufa* (Jerdon), has been ascertained by a 2-year survey of nests in the pineapple fields on Oahu. It has been found that the percentage of nests containing adult sex forms reaches a maximum sometime in the fall and a minimum in the spring. Flight has been observed to occur at sunset. The fact that females fly and that a solitary queen can initiate a colony of micrergates may account for the majority of the infestations in newly planted pineapple fields.

Some Recent Advances in Insecticides

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(Presidential Address, presented at the meeting of Dec. 9, 1940)*

The introduction of agricultural plants into a new environment is often followed by the invasion of insect pests either from wild hosts or from regions where the introduced plants were cultivated as an economic crop. The movement of an insect pest from its wild host to a cultivated one, or from one cultivated crop to another, is an old story. Man, in order to protect his crops, has made use of biological, mechanical or chemical methods for the destruction of insect pests.

Biological control may be considered the ideal method of control of an insect population. After the introduction process has been accomplished, the introduced species establishes its own population which in turn rises and falls as its host increases or decreases in population magnitude. Where agricultural crops of long duration are infested with an insect pest, then the introduced parasitic species may prove successful provided the physical environment is favorable for the reproduction of the parasite. The effect of the parasitic biotic resistance on the reproductive potential of the insect pest should be shown before the crop is harvested. Such an illustration has been amply demonstrated by the introduction of parasites into the Hawaiian Islands for insect pests of host crops, the planting of which is continuous over a period of years. Sometimes, the physical nature of the host plant involved is such as to impede the control which normally the introduced species would have upon its insect host. The Mediterranean fruitfly (larval stage) in coffee is highly parasitized, while the physical environment of the maggot in fleshy fruits gives some protection against parasitization.

So, when the agricultural crops in question are of short duration or the environment of the susceptible stage of the insect to biological control interferes, the setting up of a biotic resistance in the form of either parasite or predator may not prove successful due to the fact that the insect pest has destroyed the crop before its population can be reduced to the minimum where its presence does not seriously affect production. Then, there must be taken into consideration other means of insect pest control, which may be mechanical or chemical.

Mechanical control has been advocated and used successfully to

* This paper was not available for printing at the time the Proceedings for 1940 was printed. [Ed.]

destroy certain insects at some stage in the life cycle. Mechanical control may aid in controlling an insect pest but may not be practical as the only method for the reduction of an insect population to the minimum which may be necessary for good crop protection.

Chemical control of insect populations has been advocated and carried on in all agricultural regions especially where (1) the physical environment is such that biological control is not practical, (2) the location of the susceptible stage in the life cycle of the insect pest is protected by its environment from biological or mechanical destruction, (3) a parasite or predator for the insect pest has never been found, (4) the destruction of the entire population of the insect pest must be accomplished, (5) chemical control is more economical.

In Hawaii the environment is such that an insect may multiply rapidly with a minimum of physical resistance. The intense interest and experimentation in diversified agriculture in these islands due to the defense program, means that the entomologists here will be called upon to control a greater number of insect pests of additional economic crops. Therefore, the writer considers the time opportune for the presentation of a brief discussion on the recent developments in insecticides.

ARSENICALS

Insect toxicologists have used and continue to use lead arsenate not only as an insecticide but as a basis by which the toxicity of other chemical compounds may be compared. Because of the injury to some plants by water soluble arsenical compounds an extensive study has been made on the decomposition of acid lead arsenate in spray residues. The ratio of lead to arsenious oxide in pure acid lead arsenate is 2.09 : 1, whereas in spray residues ratios as high as 9 : 1 have been reported in the literature. The view has been held that the arsenic in spray residues weathers away more rapidly than the lead and that the acid lead arsenate undergoes gradual decomposition toward the more basic compounds of lead and arsenic. However, Fahey and Rusk [36]† in their work on the problem report findings contradictory to the results of earlier investigators. Samples of sprayed fruit and foliage were gathered for analysis from apple orchards immediately after spraying and again within a few days to as late as 75 days following applications. A total of 248 samples of apples and apple foliage were used. They state that the average ratio of lead to arsenious oxide in these samples did not vary significantly from that in the original spray material and that the high ratios obtained by earlier investigators are due probably to inadequate samples or to unreliable methods of analysis.

Ginsburg and Perlgut [44] found that small quantities of hydrogen sulfide decompose acid lead arsenate, forming large amounts of

† Numbers refer to the papers in the list of Literature.

soluble arsenic. Decomposition by hydrogen sulfide may be prevented by the addition of an excess of calcium hydroxide, as calcium hydroxide readily reacts with hydrogen sulfide, changing it to calcium sulfide. Some of the common sources of hydrogen sulfide are stagnant water and sulfur fungicides.

One of the new combinations of arsenic is a basic copper arsenate Cu (Cu OH) AsO_4 which has been presented in the literature by Witman et al [125] and Waters et al [122]. Basic copper arsenate is a definite crystalline chemical compound and is very insoluble in water; it is not subject to hydrolysis and is decomposed but little by carbon dioxide; it is compatible with lime, calcium caseinate, sulfur, Bordeaux mixture and sodium chloride solutions. Basic copper arsenate was fully as effective against Mexican bean beetle, Colorado potato beetle, and a number of other insects as acid lead arsenate or calcium arsenate. The insecticide has a slower initial effect and a more rapid final effect than lead arsenate which thus increases the chance that a toxic dose is obtained before feeding is inhibited.

In further work, Ellisor and Floyd [33] found basic copper arsenate gave a good control of the velvetbean caterpillar and exhibited unusual sticking properties without damaging soybean foliage. Felt and Bromley [38] found the material gave protection from the attacks of the black walnut caterpillar, the hickory tussock caterpillar and the fall webworm as well as a satisfactory control for the walnut leaf spot disease. However, on other pests the insecticide was not as effective and some injury of the type produced by copper occurred on fruit and foliage of apple trees.

The limited use of calcium arsenate as an insecticide has led to a further search for calcium arsenates of greater stability and uniformity. Nelson [89] found that the large percentage of water-soluble arsenic in some commercial insecticidal calcium arsenate is due to the presence of dicalcium arsenate. By atomizing a dilute solution of arsenic acid into a suspension of hydrated lime under conditions whereby the ratios of the reactants were adjusted, a product was produced which was less acid than tricalcium arsenate. Calcium arsenates of any desired composition, up to a $CaO : As_2O_5$ ratio of approximately 3.8 can be prepared by adjusting the ratio of the reacting substances.

Bulger and Nelson [13] tested a series of these calcium arsenates for toxicity to silkworm larvae. The hydrous arsenates which ranged from $CaO.As_2O_5.2H_2O$ to 4 $CaO.As_2O_5.XH_2O$, were fairly toxic while the anhydrous compounds of like series were nontoxic to the extent that no M. L. D. range was established. The hydrous tri- and tetracalcium arsenates were only about half as toxic as the mono and dicalcium compounds. The toxicity of the latter two arsenates were about equal, notwithstanding the fact that the

amount of soluble arsenic present varied greatly. The toxicity of the compounds to bean plants paralleled that to the larvae.

The results of the heat treatments of calcium arsenate suggest that the toxicity balance of these arsenates is rather delicate and that care in preparation should be exercised if the toxicity is to be maintained.

Hastings and Pepper [65] report dusts formed by mixing sodium arsenite with inert materials such as calcium carbonate, bentonite, volcanic ash, hydrated lime, were effective in treating Mormon crickets when applied either as purely contact poisons or as stomach and contact poison combined. Increase of temperature caused a decrease in the time to reach 50 percent mortality of both nymphs and adults; the degree of correlation was the higher in the case of the adults.

ARSENICAL SUBSTITUTES

Since the use of arsenic compounds as insecticides is restricted because of the arsenic and lead tolerance as well as possible injury to plant foliage, more investigators are turning their attention to other chemical compounds which may have possibilities as insecticides. Among these are the fluorine compounds, plant alkaloids, potassium antimony tartrate, organic compounds, and a number of other materials.

Chang and Campbell [22] in their recent study on the toxicology of phosphorus with respect to insects, found phosphorus was much more toxic to the American cockroach than sodium arsenite or sodium fluoride. Injection of roaches with a physiological salt solution containing phosphorus caused death, but proved less toxic than when the solution was administered by mouth. Cockroaches died when confined with phosphorus in a small closed place and the insecticide proved toxic when painted on the body of the animal. The toxic action may have been due to the action of the phosphorus vapor, or to a depletion of oxygen by oxidation of the phosphorus, or to desiccation of the insect by the oxides of the phosphorus.

Of a number of stomach poisons tested by Travis [115] for control of the fire ant, only thallium sulfate and thallium acetate were successful. Many of the compounds produced repellancy while others, although fed upon, were not highly toxic. Among the latter were the arsenates, fluorides, borax, barium chloride and tartar emetic.

Boyce and Persing [11] report promising results with tartar emetic either in dust form or in a sweet spray as a control for thrips on lemons. Anderson and Walker [2] in greenhouse tests controlled thrips on onion plants with tartar emetic-brown sugar solutions. However, control was not as good under field conditions. One application of the tartrate spray on snap beans heavily infested with onion thrips reduced the number of nymphs by more than 97 percent and prevented reinfestation for at least 7 days. Johnson and

Smith [70] found a calcium antimony tartrate spray gave results comparable with those for a tartar emetic spray of equal antimony content as a control for the gladiolus thrips. Weigel and Johnson [123] report the control of the common red spider on carnation cuttings by spraying with a tartar emetic-brown sugar solution. However, they recommend the substitution of glycerin for sugar as the glycerin eliminates the sticky sugar residue without reducing the toxicity of the spray.

The fluorine compounds as insecticides have received a great deal of attention during the last few years. Of the more recent work, Baker and Questel [3] investigated sodium fluoaluminate and a calcium fluosilicate compound for controlling the European corn borer. These materials when applied in spray form were effective and ranked about equal with derris, but as dusts were not so effective. The fluorine compounds caused more or less injury to the plants, which makes their use undesirable unless some means can be devised to eliminate their burning effects. Lincoln and Palm [77] report that the raisin-shorts-sodium fluosilicate bait still remains the best bait used in control of the alfalfa snout beetle. However, considering the ease of application and availability of materials, corncob, sugar and soybean flour may be substituted for the raisin-shorts without a decrease in toxicity. Ritcher [97] in his study of poison baits for strawberry crown borer control in Kentucky, observed that a commercial sodium fluosilicate mixed with an apple bait gave as high as 84.3 percent control of the adults in fields not surrounded by barriers.

In South Carolina, Rainwater [95] found finely ground cryolite, containing 90.8 percent of sodium fluoaluminate, when mixed with an adhesive agent, was comparable to calcium arsenate as a control for the boll weevil. However, both Gaines [41] in Texas and Young et al [129] in Louisiana observed that calcium arsenate and calcium arsenate plus sulfur were superior to cryolite as a boll weevil insecticide. Gaines found a special calcium arsenate containing large particles and a high percentage of water soluble arsenic pentoxide gave a significantly better control of both the weevil and the rapid plant bug than commercial calcium arsenate.

Carter [17] in his recent work examined 18 samples of commercial cryolites for the moisture and sodium fluoaluminate content. He discussed the particle size distribution from determinations by the sedimentation method. Goodhue and Gooden [46] describe a microprojection method and an improved sedimentation method for determining particle size distribution of insecticide materials, the latter method being favored due to the comparative ease with which results may be obtained.

The relationship between particle size and toxicity of stomach poisons has been food for thought and discussion among toxicologists. Siegler and Goodhue [102] conducted tests under controlled

laboratory conditions on the effect of particle size on the toxicity of five insecticides to codling moth larvae. Coarse particles of lead arsenate were somewhat more effective than the fine fraction. The medium fraction of calcium arsenate was more toxic than the fine or coarse particles, however, the three fractions were not of uniform chemical composition. The coarse fraction of phenothiazine was less toxic than the medium and fine fractions, yet the chemical composition of the three fractions were quite similar. In the case of Paris green and cryolite the middle size particles were more toxic yet the chemical analysis of the three fractions of each insecticide was approximately the same. This work suggests that particle size is an important consideration in the effectiveness of stomach poisons and that extremely small particles in an insecticide may not always be desirable.

In the search for organic compounds to replace the arsenicals now employed for the control of the codling moth, Siegler, Munger and Smith [103] tested over 200 compounds. Para-iodonitrobenzene was found to have high initial toxicity. In further work [104] the toxicity of certain benzene derivatives containing the halogen and nitro groups to codling moth larvae was determined. P-iodonitrobenzene, m-iodonitrobenzene, p-bromonitrobenzene and m-dinitrobenzene gave an initial toxicity of less than 50 percent wormy plugs, while in residual tests, the p-iodonitrobenzene lost most of its effectiveness in five or six days. There was no marked correlation found between either the groupings involved or their relative positions in the molecule, with regard to their toxicity to the codling moth larvae. However, Bushland [14, 15] in recent papers, states that p-iodonitrobenzene is non-toxic to the screwworm and that the alteration of the molecule in some of the compounds influenced toxicity, but no simple relationship existed between chemical constitution of an organic compound and its toxicity to screwworm larvae. Bushland lists over 550 organic compounds which were compared with phenothiazine and rotenone as insecticides. Of the 77 compounds which showed outstanding toxicity, 10 were less toxic than rotenone, 25 were equal to rotenone, 31 were equal in toxicity to phenothiazine and 11 were more toxic than phenothiazine. Of the latter 11 materials, 10 were compounds bearing the nitro group. Phenothiazine has been reported [85] as an insecticide for prevention of reinfestation of wounds on cattle by screwworm flies.

PLANT POISONS

Nicotine, either in free form or as a sulfate, has been known and used as a contact insecticide. However, in the last few years, other salts of this plant alkaloid have been prepared and tested as possible stomach poisons. Batchelder [5] in a recent publication describes a new form of nicotine-tannic acid product for controlling the European corn borer. The product, made from nicotine and extract of

quebracho wood, contains 4.35 percent nicotine, 26 percent quebracho tannins, 15 percent isopropyl-alcohol and the rest various extractive substances and water. The mixture is a thick paste, stable, convenient to handle and comparable to derris in effectiveness against the corn borer.

Pyrethrum is used as a contact insecticide but it has not been found very effective as a stomach poison. Woke [126] in a recent contribution on the subject found that the pyrethrins are inactivated wholly or in part after ingestion by the southern armyworm. The incubation of pyrethrum with the fat body and skin and muscle tissue produced the greatest reduction in toxicity, while blood, digestive tract tissue and contents of the digestive tract were much less effective in the reduction. Woke suggested that some of these tissues or their products may be responsible for the inactivation which occurs in living larvae and that it is doubtful that the tissues or secretions of the digestive tract are alone responsible. Böttcher [8, 9] of Germany has recently compared pyrethrum and derris as stomach and contact poisons on the honey bee. Both compounds were found to be toxic internally and externally. Within certain limits the toxic action of only pyrethrum was decreased by increasing temperature.

From the standpoint of chemistry, Graham [50, 52] reviewed the methods for determining pyrethrins in pyrethrum products; Gertler and Haller [43] examined the methods for preparation of kerosene-pyrethrum sprays. Martin and co-workers [83] in England, report on the fertilizer requirements for the growth of pyrethrum plants of high insecticidal value. Harvill [64] combined various compounds with chrysanthemum monocarboxylic acid, the acidic portion of the ester, pyrethrin I. Of the twenty-two esters prepared the most toxic and comparable with the unaltered pyrethrins in efficiency against *Aphis rumiçis,* were the lauryl, myristyl, cetyl, and diethanolamine esters. None of the esters produced the typical pyrethrin action when applied to various parts of the cockroach. The stability of the compounds in respect to decomposition and loss of toxicity after six months suggests that the instability of the pyrethrins is due to the ketonic alcohol, pyretholone. Trusler [117] reports on prolonging the toxicity of pyrethrum insect sprays in storage, by excluding the air or by adding an antioxidant.

Of the recent contributions on the use of the pyrethrins, Gnadinger and co-workers [45] use pyrethrin-oil spray for controlling pupae and overwintering larvae of the codling moth, pyrethrum dust, in conjunction with oil sprays, for control of adult moths and eggs. Thus, the codling moth is attacked in every stage of its life history. Walker and Anderson [119, 120] in Virginia controlled the Hawaiian beet webworm on spinach with a pyrethrum dust such as Pyrocide or a pyrethrum powder diluted to contain 0.2 percent pyrethrins. For best results, the dust should be applied when plants are dry.

Calcium arsenate and rotenone bearing dusts were ineffective. In Idaho, Coon and Wakeland [26] in their work on the repellency of pyrethrin dust, found commercial pyrethrum mixtures incorporated in diatomaceous earth were effective in entirely preventing the feeding of *Eutettix tenellus* on tomatoes for 72 to 96 hours in the greenhouse. Because of climatic factors the treatment was not so effective in the field. Barber [4] increased the effectiveness of a light mineral oil for controlling the corn earworm on sweet corn by the addition of one percent pyrethrin.

During the last two years a number of publications have appeared on the chemistry and insecticidal use of derris, cube and related products. Harper [62] isolated from the roots of *Derris elliptica* a new compound (named elliptone) with the formula $C_{20}H_{16}O_6$ and a molecular weight of 352. H. A. Jones [71] found small quantities of an alkaloid in cube and timbo roots; the alkaloid being nontoxic to mosquito larvae at a dilution of 1 : 10,000. Graham [51] describes an improved method for the analysis of rotenone in derris and cube powders, and Jones [72] contributes a review of the colorimetric tests. Goodhue and Haller [47] advance a new method for the determination of deguelin in derris and cube. Martin [82] evaluates varieties of derris, toxicologically by *Aphis rumicis* and chemically by the determination of the percentage "rotenone equivalent" which is based upon the alkaline fractionation of the resins and the toxicities of the deguelin and toxicarol fractions relative to that of rotenone. Tattersfield and Potter [113] report plants of the genus *Annona* possess contact insecticidal properties to aphids. *A. reticulata* was the most potent of those tested but was much less toxic than *Derris elliptica* root.

Allen and Brooks [1] of Wisconsin report on the effect of around thirty-five dust diluents on the toxicity of rotenone-bearing roots to houseflies. The range of the pH values of the various dust diluents was from 4.23 to 12.50. Damp storage for seven days caused a decrease in the pH of the rotenone-bearing roots without and with some of the diluents. A few of the final dust mixtures had pH values greater than those of either the insecticide or the diluent. This may have been caused by some reaction in which more hydroxyl-ions were liberated, giving rise to a more alkaline reading. Rotenone-highly alkaline dusts, after damp storage, exhibited little or no change in pH, but showed considerable loss in toxicity when used in kerosene extracts in tests with houseflies. Parallel acid dust mixtures retained their toxicity to the housefly. Sulfur prevented the deterioration of the rotenone-bearing alkaline dust mixtures.

Chisholm [24] studied the effect of light and temperature on the decomposition of derris. Sievers and Sullivan [105] found no marked differences in the toxicities of several extracts from roots of *Tephrosia virginiana,* a rotenone-bearing plant. Sullivan and coworkers [109] have recently tested a number of the optically active and

inactive compounds of the rotenone series as contact poisons on the adult housefly. The type of solvent influenced results. In acetone solution the racemic compounds were much less toxic than the optically active ones, but when tested in highly refined kerosene containing cyclohexanone, the toxicity of the two groups was approximately the same.

Sullivan, Goodhue and Fales [110] describe a new method of dispersing pyrethrum and rotenone in air. The dispersion apparatus consisted of a small atomizer with nozzle mounted seven inches above the center of an electric hot plate held at approximately 375°C. The toxicity tests were made in an 1100-cubic foot furnished room held at 28°-30°C. Seventy-two hours after spraying with pyrethrum oleoresin or rotenone in a safrol solvent, the mortality of houseflies was 74 or more percent. The combination of the two insecticides caused 95 per cent mortality. The aerosol was nontoxic to the American cockroach. An ethyl alcohol solution of pyrethrum caused 99 percent mortality of adult *Culex* mosquitoes after a 10 minute exposure.

English [34, 35] states that derris is a true toxicant for citrus whitefly and purple scale. Derris was effective for control of these insects when used in an oil emulsion spray. Gray and Schuh [55] found rotenone dust with a wetting agent, nicotine dust, pyrethrum dust and nicotine-oil dust controlled the pea aphid. However, the latter treatment was superior to the other dusts. Ditman and coworkers [30] found dusts to be slightly better than sprays in their work on control of the same insect. Derris appeared to be superior to ordinary cube. The factors of cube particle size, humidity, temperature and plant dryness at time of application influenced toxicity. Hamilton [60] has reported that cube root and phenothiazine reduced heavy populations of cherry fruitflies when at least three spray applications were made.

OTHER CONTACT POISONS

The nitrophenols, which fall in the category of contact poisons, have been receiving considerable attention. The work on 3:5-dinitro-o-cresol in dormant sprays [42, 63] has been continued. This compound has been used as an ovicide against mites and aphids, and as a control for certain insect pests of fruit trees. Hough [69] found the compound comparable to coal-tar distillate for aphid eggs. Worthley and Steiner [128] reported the sodium salt of this nitrophenol appeared only slightly toxic to eggs of the European red mite, while Felt and Bromley [38] state that a commercial preparation containing a salt of dinitro-cresylate gave good control of the eggs of the spruce red mite, European red mite, the spruce gall aphid and the oyster shell scale. Shaw and Steer [99] tested 44 organic preparations as ovicides. The 3:5-dinitro-o-cresol was highly toxic to the aphid and red spider eggs but less toxic to eggs of two species

of moths. Other effective ovicides were n-dodecyl thiocyanate, B-butoxy-B′-thiocyanodiethyl ether, and nicotine.

Callaway and Musgrave [16] found B-butoxy-B′-thiocyanodiethyl ether to be superior to some other liquid organic insecticides as an ovicide for eggs of *Cimex lectularius*. In further work, Potter and Musgrave [93] state that this thiocyanate has distinct possibilities of becoming an industrial insecticide. The insecticide appeared to be particularly toxic to the eggs of the bedbug, grain weevils and a number of pests of stored agricultural products. Boyce et al [10] have produced promising results with dusts made by diluting dinitro-o-cyclohexylphenol with walnut shell flour. The compound may be applied to citrus and other subtropical plants with greater safety as a dust than as an aqueous dispersion. Morrison and Mote [86] found this nitrophenol in dust form controlled the common red spider on hops. Rotenone, pyrethrum and nicotine sulfate, although compatible when added to the dust, did not contribute to added toxicity. Grayson [56] found the ovicidal effectiveness of petroleum oil against European red mite eggs was slightly increased by the addition of dinitro-o-cyclohexylphenol although this compound when used as a wettable powder without the oil was ineffective as an ovicide.

The wetting, spreading and adherent properties of sprays are being continuously investigated by entomologists. Cupples [28] in a continuation of previous work [27] reports on inorganic salts as adjuvants for increasing wetting power. The addition of chlorides of calcium, magnesium or sodium to solutions of a sulfonated ester of dicarboxylic acid, produced significant increases in wetting power, as measured by surface tension or by spreading coefficient on mineral oil.

Brown and Hoskins [12] show that the pH of spray water has an important relation to the amount of oil deposited by petroleum oil emulsion. Wampler and Hoskins [121] discuss the electric charge on the spray droplets in relation to spray deposits. In a recent paper Upholt and Hoskins [118] present the design and use of a photographic apparatus for studying the impact and movement of individual drops upon a surface. Hensill and Tihenko [67] have studied some of the mechanical and other factors affecting oil spray deposits.

REPELLENTS AND LURES

Investigators have continued their work on the problem of mosquito control and repellents. Powers and Headlee [94] state petroleum oils kill the eggs of *Aedes aegypti* L. by depriving the eggs of oxygen, thus causing suffocation. The ovicidal efficiency of petroleum oils was affected by viscosity and egg coverage. Murray [87] has contributed a publication on the efficiency of petroleum oils as mosquito larvicides.

In the search for chemicals possessing mosquito repellent properties MacNay [80] found the essence of thyme and geranium, cinnamic aldehyde, cresol and some tar distillate fractions were repellent to mosquitoes. A large number of organic compounds have been tested by Granett [53, 54] at Rutgers University. In recent papers the method of testing and evaluating mosquito repellents are described. Out of nearly one thousand materials, a repellent product was developed, which consisted of diethylene glycol monobutyl ether acetate, diethylene glycol monoethyl ether, ethyl alcohol, corn oil, and perfume. The mixture is harmless to all fabrics except acetate rayon. In tests against black flies, sand flies, deer flies and chiggers, frequent applications of the repellent were necessary; however, the mixture had the same relative order of superiority over the other materials. Kilgore [75] has found diethylene glycol monobutyl ether acetate to be repellent to house flies.

Using a new type of olfactometer, Wieting and Hoskins [124] reported that female house flies are attracted to ammonia and males to alcohol, whereas carbon dioxide was not attractive to either sex. Eagleson [32] described the construction and use of an olfactometer for muscoid flies and discussed a method for interpreting results. According to Deonier [29] blowflies were found to have on the tarsi and proboscis, gustatory chemo-receptors through which nonvolatile substances can be detected. The flies were strongly repelled by mercuric chloride solutions.

Marlowe [81] tested a number of mixtures as deterrents to the melonfly. Nicotine sulfate plus either Bordeaux mixture or red cuprous oxide gave best results as represented by increase in production of non-infested cucumbers. Ferguson [39] in his studies on coal tar insecticides found calcium pitchate and copper pitchate to be repellent to Mexiçan bean beetle larvae. The latter compound in effectiveness was comparable to 0.75 percent rotenone dust and cryolite dust. Guy and Dietz [58] and Pierpont [91] have discussed the repellent efficiency of tetramethylthiuram disulfide; this compound being more repellent than derris to the Japanese beetle. Fleming and Burgess [40] working on the attractiveness of geraniol and eugenol to this beetle found an almost equal mixture of the two chemicals was more attractive than either of the baits alone.

Some investigators have added sweet substances as feeding attractants to stomach poisons. Siegler [101] observed that under laboratory conditions, the addition of brown sugar to lead arsenate, calcium arsenate, nicotine bentonite, and phenothiazine increased the toxicity of these insecticides to codling moth larvae. Sucrose, corn syrup, d-fructose, glycerine, and malic acid improved the effectiveness of lead arsenate. The addition of the larval attractant to the insecticide caused a marked reduction in percentage of stings, thus indicating that a higher percentage of the larvae ingested a

toxic dose before they ruptured the skin of the apple than when the attractant was not used with the poison.

Of the recent papers on attractants, McPhail [84] reported that proteins in the presence of sodium hydroxide solution made very satisfactory field lures for the Central American fruitfly, and Travis [116] observed that isoamylamine was attractive to male June beetles. Götz [48] found the scent of unfertilized females of two species of the European vine moth to be attractive to the males. Traps containing unfertilized females caught a much greater number of males than the most effective bait hitherto known. Unfertilized females remain attractive throughout their life, the scent being stronger the second day after emergence. There is a possibility of using the sex scent in control as the males generally appear before the females. For practical work it will be necessary to produce the scent synthetically.

FUMIGANTS

Considerable experimental work has been conducted to determine the action of various fumigants on the different stages of insects. Gunderson and Strand [57] found hydrogen cyanide to be more toxic to all stages of the bedbug than ethylene oxide or chloropicrin. The eggs were less resistant to hydrogen cyanide and ethylene oxide than were nymphs and adults, while the reverse was true of chloropicrin. The nymphs and adults were similar in their reactions to each fumigant. However, Gough [49] observed the order of resistance of the confused flour beetle to hydrogen cyanide to be: pupae, adult, larva and egg. It was found that the offspring of resistant individuals was significantly more resistant than the offspring of susceptible individuals, and that this difference was maintained over several generations. Such resistance is not carried over into the eggs of the black scale as Swain and Buchner [111] found the resistance of black scale eggs to cyanide fumigation was influenced by locality and season. However, high concentrations of HCN may be used in the winter as winter eggs are less susceptible to the fumigant than summer eggs. Also, earlier season fumigation is recommended.

The use of methyl bromide as an insect fumigant has increased greatly during the last year. Methyl bromide has been used for fumigating insects of stored food products [100]; Japanese beetle grubs and adults on fresh fruit and produce [31]. Soil fumigation with methyl bromide has been successful for the Asiatic beetle grub [59] and the white-fringed beetle grub, *Pantomorus* [78]. Chapman [21] obtained excellent kill of *Rhagoletis pomonella* maggots in apples with the fumigant. Lange [76] found the chemical gave practically a perfect kill of the artichoke plume moth larvae within planting stock at standard dosages. Mackie and Carter [79] report the results of one season's activities in the industrial application of methyl bromide to Bartlett pear fumigation for codling moth larvae. Methods, equip-

ment, factors influencing fumigation and the economical problem are discussed thoroughly.

Another fumigant which has been receiving attention is dichloroethyl ether. It has been used as a soil fumigant, for control of the pear thrips [73] and the larvae and pupae of the plum curculio [107]. The application of the chemical in mineral oil gave control of the corn earworm in sweet corn [90]. Other fumigants and their uses are ethylene dichloride emulsion for the peach borer [19]; paradichlorobenzene for the black peach aphis [20] and as a fumigant for the larvae of the black carpet beetle [25]. Schwardt and Lincoln [98] obtained excellent control of the larvae and adults of the alfalfa snout beetle in Northern New York by fumigating the soil with carbon bisulfide. Under the locality conditions (climatic and soil) which existed, carbon bisulfide was found to be more dependable than chloropicrin, methyl bromide, carbon tetrachloride, dichloroethyl ether or orthodichlorobenzene.

There has been a lack of reliable methods of and information on the testing of termite-proofing materials. In April the Termite Committee of National Pest Control [114] announced certain fundamental principles of operation necessary for the control of termite infestations in woodwork in buildings.

The use of soil poisons for control of the subterranean termites has been rapidly expanding. Hockenyos [68] found trichlorobenzene and polychloropentane to be much superior to the orthodichlorobenzene now commonly recommended. Sodium pentachlorophenate also was highly toxic and repellent but it is easily removed from solution by the soil. Sodium arsenite and sodium arsenate were the best of the inorganic compounds studied. Smith [106] Ohio State University tested ten organic compounds as soil poisons for subterranean termites. He found diphenylamine to be remarkably repellent and toxic. The compound was effective ten days after soil treatment as compared with the time-effective limit of 60 to 72 hours for orthodichlorobenzene.

Headlee and Jobbins [66] were able to protect wood in the soil from the common termite (*Reticulitermes flavipes*, K.) for more than a year by treating the soil with 0.05 pounds of acid lead arsenate per cubic foot. The results of this work indicate that investigators may have overlooked a cheap and practical method for control of termites.

MISCELLANEOUS

Certain so-called inert materials have a lethal effect on some insects when dusted on their bodies. The toxicity of the inert materials is attributed to their desiccating and mechanical irritating action on the insect. Against the rice and granary weevils, Chiu [23] found crystalline silica was more effective than magnesium carbonate, amorphous silica, bentonite, talc or walnut shell flour. Low relative humidity, and a decrease in particle size within a certain

range, increased the insecticidal efficiency of the crystalline silica dust.

Most of the recent publications on the removal of spray residues have been on the washing of sprayed apples. Cryolite residues may be removed with dilute hydrochloric acid, boric acid, and sodium chloride at the proper temperature [74] while the technique for removal of nicotine residues from apples is improved by a wash of sodium silicate [18]. Fahey and Rusk [37] in their studies on the effect of fruit growth and weather on deposits of insecticides on apples found fixed nicotine to be less susceptible to weathering than phenothiazine, and lead arsenate was least susceptible of the three insecticides.

Neiswander and Morris [88] have brought up the question again of whether a toxicant might be added to a nutrient solution as a means of control for phytophagous mites and insects. The results of their studies have shown that when the selenium concentration of foliage approached 90 to 100 p.p.m. the red spider was practically eliminated, and 45 p.p.m. controlled the black chrysanthemum aphid. Although selenium is toxic to higher animals, the method offers an approach to pest control, particularly on ornamental plants.

A number of the papers which have been referred to, present information on the statistical analysis of toxicity data. Tattersfield [112], Potter and Hocking [92], Woodbury and Barnhart [127], Hansberry and Chiu [61], Steiner [108], and Bliss [6, 7], are the principal investigators who have recently submitted contributions on methods of testing insecticides and statistical analysis of toxicity data. Richardson [96] of Iowa has presented a very interesting publication on advances in entomology during 1939, and 1940.

Without a doubt some recent publications on insecticides have been missed but it is hoped that the field has been sufficiently covered to give you a realization of the advances which have been made during 1939 and 1940 in insect pest control.

SUMMARY

During the last two years a great amount of work on the properties and toxicity of chemical compounds as insecticides has been published. New insecticides have appeared and new uses of old insect poisons have been found. Lead arsenate does not decompose greatly under field conditions which is contradictory to reports of earlier investigators. The decomposition which does take place is caused by hydrogen sulfide in spray waters. A new arsenate combination is basic copper arsenate, which is toxic to various species of caterpillar. However, the insecticide has been reported as causing some foliage injury. The presence of water in the molecule of calcium arsenates influenced toxicity. The factor of particle size influenced the toxicity of lead and calcium arsenate, Paris green, cryolite and phenothiazine to codling moth larvae. The results indicated

that extremely small particles in an insecticide may not always be desirable.

Some of the fluorine compounds have been reported on as control measures for the corn borer, boll weevil, alfalfa snout beetle and the strawberry crown borer. Thallium salts were successful in controlling the fire ant. Tartar emetic is being used for control of thrips and red spider on flowers.

A new nicotine-tannic acid product has been prepared which is comparable to derris in effectiveness against the corn borer. Of the 550 organic compounds which were tested against the screw-worm, those containing the nitro group were among the most toxic. Other work with the organic compounds has shown that there is no marked correlation between toxicity to codling moth larvae and the groupings involved or their relative position in the molecule.

Pyrethrum loses its toxicity when ingested by the southern armyworm; the inactivation being caused by tissues and their products in the living larvae. Instability of pyrethrins in storage is due to the ketonic alcohol. The addition of an antioxidant will aid in prolonging the toxicity of pyrethrum sprays. A new compound (elliptone) has been isolated from roots of *Derris elliptica* and plants of genus *Annona* have been found to possess insecticidal properties. The deterioration of rotenone in storage is greater when mixed with alkaline dust diluents than when the diluents are neutral or acid. Derris or rotenone has been reported as a control for citrus whitefly, purple scale, pea aphid, cherry fruitfly and in an aerosol for mosquitoes and house flies.

Of the nitrophenols, B-butoxy-B′-thiocyanodiethyl ether was found to be quite toxic to the eggs of the bedbug, grain weevils, some pests of stored agricultural products, red spider and European red mite eggs. The best product which has been developed out of nearly one thousand materials as a mosquito repellent consisted of diethylene glycol monobutyl ether acetate, diethylene glycol monoethyl ether, ethyl alcohol, corn oil and perfume. The first constituent of the above compound has been found to be repellent to house flies. Other deterrents to insects which have been reported on are: mercuric chloride solutions, tetramethylthiuram disulfide, nicotine sulfate plus Bordeaux mixture or red cuprous oxide, calcium pitchate and copper pitchate. The addition of sweet substances as attractants has increased the toxicity of some insecticides to the codling moth larvae. For trapping lures, proteins have been reported for the Central American fruitfly; unfertilized females of two species of vine moth were attractive to males of the same species, and isoamylamine has been found attractive to male June beetles.

A number of publications have appeared on work with such fumigants as: hydrogen cyanide, chloropicrin, ethylene oxide, dichloroethyl ether, paradichlorobenzene, ethylene dichloride, car-

bon bisulfide and methyl bromide. Methyl bromide has been used for fumigating insects of stored food products, larvae in apples, Japanese beetle grubs and adults on fresh fruit and produce, artichoke plume moth larvae, soil fumigation for the Asiatic beetle grub and the white-fringed beetle grub.

Soil poisons for control of subterranean termites which have been reported are: trichlorobenzene, polychloropentane, diphenylamine, lead arsenate, sodium arsenite and sodium arsenate.

Seven publications are cited that contain information on the statistical analysis of toxicity data. The literature citations contain 129 references.

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Ear Worm Control in Sweet Corn[1]

BY CARL T. SCHMIDT
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(Presented at the meeting of April 14, 1941)

The corn ear worm, *Heliothis armigera* (Hübner), is a serious pest of corn in the Hawaiian Islands and when it attacks certain varieties of corn the result is essentially a complete loss of the crop. The necessity for a control measure became apparent in the pilot plots planted for the Pineapple Producers Cooperative Association Emergency Committee on Food Production. The method suggested by Barber,[2] using highly refined mineral oils both alone and in combination with pyrethrum, seemed to offer the greatest possibilities for the present purpose and accordingly was tried with some modifications from the originally described method.

The insecticidal materials tested were Oronite Crystal oil (Standard Oil Co. White Oil No. 7) a highly refined mineral oil of 145-155 Saybolt viscosity at 100° F. and an unsulfonated residue exceeding 90 per cent. This oil was applied alone and also with the addition of 0.05 per cent rotenone in the form of derris extract in camphor oil. This latter material is stated by the manufacturer to contain 5 per cent rotenone in a total of 20 per cent extractive, dissolved in camphor oil. Thirty-six cubic centimeters of this material added to one gallon of oil gives a mixture of 0.05 per cent rotenone content.

The oil was applied by means of an ordinary mechanic's pressure oiler which was obtained from a local automobile supply house. This was calibrated by inserting a small copper ring beneath the plunger to limit the material ejected to 0.8 cc. with each depression of the plunger. This oiler is shown in Fig. 1. While this device was adequate for experimental purposes, it would be necessary to modify it by the addition of a supply unit to obviate the necessity for frequent refilling of the supply chamber. The exact form of the oiler is unimportant save that it deliver a constant volume irrespective of the quantity remaining in the supply reservoir.

The oil was placed on the silk as near to the tip of the ear as possible. The oil drops spread very quickly on contact with the silk and seep into the inner silks of the ear and any larvae therein are killed when the oil comes in contact with their body surfaces.

[1] Published with the approval of the Acting Director as Miscellaneous Paper No. 36 of the Pineapple Research Institute of Hawaii, University of Hawaii.

[2] Barber, Geo. W. 1940. The use of oil containing pyrethrins for ear worm control in sweet corn. U.S.D.A. Bur. of Ent. and Plant Quar. Mimeo. Circ. E 497.

The resistance of larger larvae is probably due to insufficient contact with the oil. It was noted that the larger larvae tended to crawl out of treated ears, probably because the oil rendered the silks unpalatable. There was a distinct temporary flavoring by the camphor of the tips of the ears where the derris extract was used but this disappeared and was no longer detectable either to taste or smell after the third day. No other effect of the insecticide was apparent on any of the treated plants.

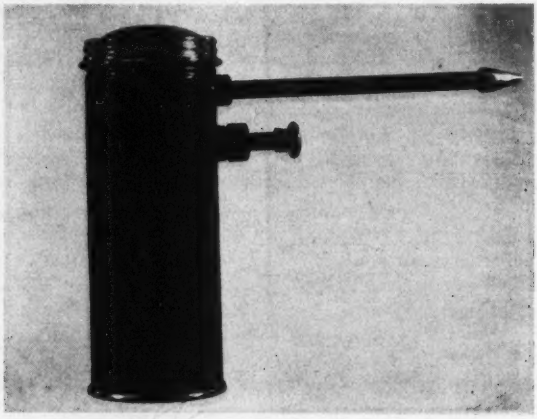

Fig. 1. Mechanic's oiler used for applying oil to corn silk.

The application of oil to the silks of corn is known to interfere with pollination so that it is essential to delay treatment until the silks are no longer functional. Dependent somewhat on weather conditions, pollination is completed within three days after the silks are first exposed at the tip of the ear. Once the kernel is fertilized the silk serves no further purpose and oils can be applied without danger of damage. In actual practice the wilting of the silk is the best indicator of the time to proceed with the control measure. If the stand is maturing uniformly a single treatment of the field may suffice though if some plants are delayed, a second treatment may be required for the retarded ears. The oils are definitely more effective in killing early instar larvae so that too great a delay in time of treating may allow larvae to mature to a point where damage may be expected despite attempted control.

The corn treated in the present experiment was U.S.D.A. Sweetcorn No. 34 growing in a pilot plot of the California Packing Company at Kemoo Farm, Oahu. Treatments were made on February 26, 1941, and 2 weeks later the roasting ears were harvested,

brought into the laboratory and examinations made for living larvae and extent of damage. A distinction was made between perfect ears and those with larvae present but no damage done to the ear. However, from the standpoint of marketability the consumer would not object to small larvae which might be present in the silks. The results are shown in Table 1. The oil plus derris extract treatments are shown to give a superior control by nearly 4 per cent which is a sufficient differential to merit its use.

SUMMARY

The use of white mineral oils either alone or with the addition of rotenone in the form of derris extract gave a satisfactory control of the corn ear worm when applied to the wilted silks with a mechanic's oiler. Damage to the extent of 10.6 per cent occurred where oil alone was used, 6.2 per cent where derris extract was added as compared to 60.8 per cent in the untreated checks.

TABLE 1.

Results of treatment of corn ears with Crystal oil and Crystal oil plus 0.05 per cent rotenone in the form of derris extract

	Crystal Oil	Crystal Oil Derris Extract	Untreated Check
Total number of ears	104	97	51
Perfect ears, no larvae	85	88	5
Larvae present but no damage	8	3	15
Larvae present, tip damage	11	6	31
Per cent perfect ears	81.7	90.7	9.8
Per cent marketable ears	89.4	93.8	39.2
Per cent tip damage	10.6	6.2	60.8

An Immigrant Tenebrionid Beetle New to Hawaii

BY O. H. SWEZEY
Experiment Station, H.S.P.A.

(Presented at the meeting of November 10, 1941)

In determining a collection of insects made at light by Mr. A. C. Browne at his residence on Kalawahine Place, Oct. 28, 1941, two beetles were found of a species which has not been previously reported in Hawaii. Apparently they are the cosmopolitan species *Lyphia tetraphylla* (Fairm.) which was described on a single specimen taken in the vicinity of Pisa, Italy. (*Bius tetraphyllus* Fairmaire, Ann. Soc. Ent. France, (3), IV, p. 534, 1856). There are seven species of *Lyphia* listed in the Junk Coleoptera Catalog. They are mostly described from meager material, and very few references are given in literature. They are from such scattered places as Japan, Australia, Tasmania, Algeria, Madagascar, and *tetraphylla* is cosmopolitan according to the Leng Catalog, where two synonyms are given: *ficicola* and *rugosus*. The localities given in United States are District of Columbia and Ohio. I have found no recent records, but it may be present in localities without attracting attention. It is quite likely that this species has become established from the Pacific coast of United States. The descriptions of the species in literature are not very distinctive, apparently all species being very similar in color and size.

Perris has given a description of the larva of *ficicola,* which is a synonym of *tetraphylla,* from specimens collected in old grape vines, and dead branches of fig and live oak. He expressed the opinion that the presence of these larvae was due to the presence of other insects to which they may be attached or associated with, rather than having any connection with the cause of the dead branches. (Perris, Larves de Coleopteres, Paris, p. 283, 1877.)

(NOTE: The two specimens were later studied by Dr. F. E. Blaisdell, who ascertained that they were not *tetraphylla,* and thought that they might be *angusta* (Lucas), the determination being from literature only, not having specimens at hand for comparison.)

Corrections in Use of the Name Oechalia grisea (Burm.) (Hem.)

BY O. H. SWEZEY
Experiment Station, H.S.P.A.

(Presented at the meeting of November 10, 1941)

In arranging specimens of the Genus *Oechalia* in the Experiment Station, H.S.P.A. collection in accordance with Dr. Usinger's revision of the genus which appeared in the last number of the "Pro-

ceedings" (XI, No. 1, pp. 59-93, July, 1941), and in comparing our material with specimens returned by Dr. Usinger, authentically labelled by him, it is evident that in the previous issues of our "Proceedings", the name *grisea* (or *griseus*) has been used often when other species have been involved, as they are now known. It may be advisable to segregate in one place, corrections that could be made in regard to this. Hence, I have undertaken to do this as far as I am able.

Oechalia griseus on page 18, Vol. I, should be *kaonohi* Kirkaldy.

On pages 11 and 278, Vol. V, *grisea* is probably *acuta* Usinger, which is the species occurring in the Kohala mountains.

On pages 281 and 282, Vol. VI, *griseus* is in error, but it is not possible to say whether it should be *bryani* Usinger or *virgula* Van Duzee without seeing the specimen, which was caught on the top of Mauna Loa.

On pages 303, 495, 497, 498 and 502, Vol. VII, *griseus* should be *pacifica* (Stal).

On page 188, Vol. VIII, *griseus* should be *bryani* Usinger.

Some Corrections in the Use of Names for the Species of Nysius in Hawaii (Hem.)

BY O. H. SWEZEY
Experiment Station, H.S.P.A.

(Presented at the meeting of November 10, 1941)

In arranging in the Experiment Station, H.S.P.A., cabinets, returned material of this group of bugs which had been studied by Dr. Usinger in his Revision of this group, I found that I could, from this material, correct some of the species names of *Nysius* which have been recorded in the preceding volumes of the "Proceedings of the Hawaiian Entomological Society". There has been confusion in the use of a few of the species names, from the lack of having at hand authentically determined specimens. Now, with the use of specimens determined by Dr. Usinger after prolonged study, there should be no particular difficulty in determining any *Nysius* which comes to hand.

Our collection does not contain all of the species recognized by Dr. Usinger, and for many of the species there are only one or two specimens. Further collecting may supply some of these species which are lacking and also more specimens of species with meager material at present.

I have been able to make the following corrections in the records in the "Proceedings", and to supply specific names for some of the records of "*Nysius* sp." No doubt there are some misidentifications

which I am not able to correct, not having access to the specimens concerned in all of these misidentifications.

Vol. III, page 295: *"Nysius delectus"* = *"N. coenosulus* Stal".
" III, " 295: *"Nysius* sp." = *"N. nemorivagus* White".
" VI, " 282: *"Nysius delectus"* } Not verified as was unable to see the specimens.
" VI, " 282: *"Nysius coenosulus"* }
" VI, " 420: *"Nysius* sp. Kawela, on *Lythrum"* = {*"N. terrestris* Usinger", *"N. coenosulus* Stal".
" VI, " 420: *"Nysius* sp. Kawela, on *Metrosideros"* = *"Oceanides montivagus* (Kirk.)"
" VI, " 420: *"Nysius* sp. Kawela, host not recorded" = *"N. delectus* White".
" VII, " 185: *"Nysius* sp." = *"N. communis* Usinger and *N. terrestris* Usinger".
" VII, " 284: *"Nysius* sp." = *"Nysius delectus* White".
" VII, " 303: *"Nysius* sp." Kamiloloa = *"N. delectus* White".
" VII, " 306: *"Nysius* sp." on *Metrosideros* = *"Oceanides montivagus* (Kirk.)".
" VII, " 310: *"Nysius* sp." on *Pipturus* = *"Neseis (Trachynysius) swezeyi* Usinger".
" VII, " 313: *"Nysius* sp." on *Sadleria* = *"Nysius montivagus* (Kirk.)".
" VII, " 495: *"Nysius* sp." = *"N. communis* Usinger and *N. nigriscutellatus* Usinger".
" VII, " 497: *"Nysius* sp." = {*"N. terrestris* Usinger". *"Neseis mauiensis* (Blackburn)".
" VII, " 498: *"Nysius* sp." = {*"N. communis* Usinger". *"Neseis mauiensis* (Blackburn)".
" VII, " 502: *"Nysius* sp." = {*"Neseis mauiensis* (Blackburn)". *"Neseis mauiensis* var. *pallidipennis* Usinger".
" VIII, " 188: the species of *Nysius* are:
on koa: *blackburni* White.
on *Raillardia: communis* Usinger and *nemorivagus* White.
on *Sophora: nemorivagus* White and *lichenicola* Kirkaldy.
on *Astelia: Neseis whitei* var. *brachypterus* Usinger.

" VIII, " 191 and 192: *"Nysius delectus* White" = *"N. coenosulus* Stal".
" IX, " 43: *"Nysius delectus* White" = *"N. terrestris* Usinger".
" IX, " 95: *"Nysius delectus* White" = *"N. terrestris* Usinger".
" IX, " 97: *"Nysius delectus* White" = *"N. communis* Usinger".
" IX, " 139: *"Nysius coenosulus* Stal", probably is *communis* Usinger".
" IX, " 206: *"Nysius* sp." = *"Neseis oahuensis* Usinger".
" IX, " 357: *"Nysius"* n. spp. =
{*"Oceanides myopori* Usinger".
}*"Neseis nitidus impressicollis* Usinger".
" X, " 189: *"Nysius coenosulus* Stal" is probably *N. delectus* White, as this species has been recorded from that locality, but can't be sure for the specimens have been mislaid.

Notes on Food Habits of Lepidoptera in Samoa

BY O. H. SWEZEY
Experiment Station, H.S.P.A.

(Presented at the meeting of December 22, 1941)

While on a collecting trip in Samoa during June, July and August, 1940, with Mr. E. C. Zimmerman of the Bishop Museum, I gave special attention to the rearing of lepidopterous larvae, and thus determining so far as possible the feeding habits of as many species as I was able, being continually on the search for caterpillars in whatever locality explored by us. Many new records were obtained in this way, and also some new species were discovered, not all of which have as yet been determined and described. Besides those reared, much material was obtained by light trap, and many species obtained which were not represented in Samoan collections at Bishop Museum.

BUTTERFLIES

Danaida plexippus (Linn.)

At Afiamalu, Upolu, 2200 ft. elevation, July 10, 10 eggs were found on the leaves of a small plant of *Asclepias curassavica.*

At Apia, on the peninsula, July 14, two half-grown caterpillars were observed on the same plant. (Not reared.) At Tutuila full-grown caterpillars were found on the same plant at Fagatoga, reservoir trail, Aug. 3, and on the Leone Road, Aug. 7.

Hypolimnas errabunda Hopkins

In the forest at Afiamalu, June 14, seven of the black spiny caterpillars were found on the leaves of a large-leaved shrub (*Cypholophus macrocephalus*). Four chrysalids were formed June 30 and the butterflies issued July 18. On June 30 at another location in the forest at Afiamalu, three more caterpillars were obtained on the same plant. Chrysalids were formed July 17, and the butterflies issued July 28.

Euploea elutho bourkei Poulton

One caterpillar was collected on leaf of *Ficus tinctoria* at Amouli, Tutuila, 400 ft. elevation, Aug. 2. Three tachinid maggots issued Aug. 7 which produced adult flies Aug. 20 (Not yet determined.) Another caterpillar was found on the same plant at seashore, Utulei, Tutuila, Aug. 21. This caterpillar was preserved as there was not time for rearing before departure on homeward trip.

Precis villida villida (Fab.)

Two caterpillars were found on sweet potato leaves at the Experimental Farm, Taputimu, Tutuila, Aug. 7 by Mr. Zimmerman. One caterpillar was preserved, and the other one reared, the chrysalis being formed Aug. 14 and the butterfly emerging Aug. 22. At Mr. Ben Gurr's vegetable garden at 700 ft. elevation, Moloata, Tutuila, Aug. 27, I observed the butterflies flying over a sweet potato patch, and a few caterpillars on the leaves.

The caterpillar and chrysalis were not described by Hopkins in "Insects of Samoa", hence, brief descriptions herewith. The full-grown caterpillar is about 40 mm. in length. Black, with minute white speckles all over; regularly covered with spiny tubercles, the two lateral rows above and below spiracles are pale brown at base; head hairy or with slender spines, two short tubercles on vertex; spiracles oval, black.

The chrysalis is 15 mm.; grayish brown, mottled with pinkish white specially on wing cases and two longitudinal rows on back, and a transverse ring about mid-dorsum of abdomen, also on terminal segments.

Melanitis leda solandra (Fab.)

Caterpillars were found quite common on sugar cane leaves at the Experimental Farm, Taputimu, Tutuila, Aug. 7. Two butterflies were reared Aug. 26. Caterpillars were found on *Miscanthus japonicus* at three places on Tutuila: near the hotel, Aug. 17; Breaker Point, Aug. 19; Fagatoga, near the power house, Aug. 25. Also a green chrysalis on leaf at latter place.

Jamides argentina (Prittw.)

Two butterflies were reared from larvae feeding in flowers of *Vigna marina* on the peninsula at Apia, Upolu, July 14. Eggs on buds and blossoms of the same plant were found at Utulei, Tutuila,

Aug. 17. The butterfly was observed about the plants at this place, also at Breaker Point, Aug. 19, and larvae were collected.

Catochrysops lithargyrea pepe Hopkins

This blue butterfly was reared from larva feeding in flowers of *Desmodium umbellatum* at the shore line Utulei, Tutuila, Aug. 17. The butterfly emerged Aug. 30.

Skipper (undetermined)

Larvae were found feeding in rolled tips of the new terminal leaves of young rattan palm plants, at Malololelei, Upolu, July 8, and at Tapatapao, Upolu, July 17, but not reared. At the latter place two *Apanteles operculinae polita* Fullaway were reared from the caterpillars.

SPHINGIDAE

Herse convolvuli (Linn.)

Larva on leaves of *Ipomoea pes-caprae* on the peninsula, Apia, Upolu, July 14 (Zimmerman). Not reared. Two caterpillars on *Ipomoea* sp. at 600 ft. elevation north side of Pago Pago harbor, Tutuila, Aug. 6. (Preserved.) One caterpillar on leaves of sweet potato at Ben Gurr's, Moloata, Tutuila, Aug. 27.

Chromis erotus eras (Boisd.)

Caterpillars were collected on leaves of *Morinda citrifolia* at Amouli, 400 ft. Tutuila, Aug. 2, and shoreline Utulei, Tutuila, Aug. 17. (Preserved, as not yet matured when we started for return to Honolulu.)

Hippotion celerio (Linn.)

Caterpillars collected on taro leaves at Tapatapao, Upolu, July 21. Five moths emerged Aug. 9-25. At Sinaele, Upolu, July 27, eggs were observed on taro leaves, and 10 small caterpillars; 2 large caterpillars collected from which moths matured Aug. 20-22. On Tutuila, a few small caterpillars were found on taro patches wherever visited: North side of Pago Pago harbor, 600 ft. el., Aug. 6 and 16; Fagatoga, 800 ft. el., Aug. 12 and 25; Fagatoga, 1000 ft. el., Aug. 28.

GEOMETRIDAE

Thalassodes chloropis Meyr.

One caterpillar collected on *Rhus taitensis* at Utulei, 800 ft. Tutuila, Aug. 18. Moth emerged Sept. 4.

Cleora samoana (Butler)

One caterpillar on *Eugenia* sp. (?) at Afiamalu, Upolu, June 14. The adult moth emerged July 8. For a moth which came to lights so abundantly, it is remarkable that I found the caterpillar but once.

AGROTIDAE

Heliothis assulta Guenée

Two caterpillars were found at Tapatapao, Upolu, July 23, feeding on the green fruits in their husks, of *Physalis minima,* going from one to another, thus consuming a large number of fruits before getting their growth. The moths emerged Aug. 10 and 12. Full-grown caterpillar was 30 mm.; yellowish green, minutely chagreened on the surface like the caterpillar of *H. armigera;* head uniform light brownish or testaceous; cervical shield with lateral and transverse black markings; setae on body segments situated in conspicuous black, round dots; a yellowish patch above each spiracle, each with fuscous marking before and posterior to it; spiracles slightly oval, black; thoracic legs fuscous.

At Ben Gurr's garden above Moloata, Tutuila, Aug. 27, the caterpillars were very abundant, nearly every plant being affected in a small patch of tobacco. Daily handpicking was resorted to to save the crop. At the same garden an occasional green tomato was eaten into and spoiled.

Prodenia litura (Fab.)

The worst taro pest in Samoa. Always to be found in one stage or another in any taro patch visited on Upolu: Apia on ridge towards Mt. Vaea, June 2, hundreds of small larvae were found on a single taro leaf; Aliesa, June 4; Afiamalu, June 9, 22, July 2, all stages, sometimes three egg clusters per leaf, with two or three hundred eggs per cluster; Sinaele, July 27, caterpillars abundant, three small ones with *Euplectrus* pupae, the parasites issuing July 31, a species which differs from *platyhypenae* in Hawaii. On Tutuila it was not found so abundant except in one place on the slope north side of Pago Pago harbor, Aug. 6, and Fagatogo, 1000 ft. Aug. 28.

A colony of *Prodenia* caterpillars was found on banana leaf at Afiamalu, Upolu, June 9, and another at Amouli, Tutuila, Aug. 2. At Blunt's Point, Tutuila, Aug. 17, a colony on *Mimosa pudica.* At Breaker Point, Tutuila, Aug. 19, several caterpillars on *Ipomoea pes-caprae.*

Spodoptera mauritia (Boisd.)

Caterpillars were abundant in lawn at the Afiamalu mountain house, Upolu, June 12. Egg clusters were very abundant on a small citrus tree. Thirty-two clusters were counted (mostly hatched), and there was no evidence of egg-parasites. One moth was reared, emerged July 7. At the U.S. Naval Station, Tutuila, Aug. 10, old hatched egg-clusters were common on leaves of young coconut trees on the golf course. At the same place, Aug. 15, the old hatched egg-clusters were so abundant on a small Royal palm that 160 of them were counted on a single leaf. They were similarly numerous on

other leaves, many of them showed that parasites (possibly *Telenomus*) had issued from them, but none were found containing parasites. Three fresh egg-clusters were found from which the caterpillars hatched in a few days. None parasitized.

Cirphis unipuncta (Haw.)

One moth was reared from caterpillar found in grass lawn at Afiamalu, Upolu, June 13. The moth emerged July 16. This moth was not previously recorded in Samoa.

Earias luteolaria Hampson.

At Fagatoga, 600 ft., Tutuila, Aug. 12, a caterpillar was found under loose bark of *Hibiscus tiliaceus* apparently searching for a secluded place for spinning its cocoon. In a tin box it made a tough dense cocoon from which the moth issued Aug. 26.

Plusia chalcites (Esp.)

Three caterpillars collected from *Ipomoea pes-caprae* on the peninsula, Apia, Upolu, July 14 were all parasitized. July 17, 28 parasite larvae issued and formed while cocoons from which the adult parasites issued July 22. Identified by Mr. Fullaway as *Apanteles expulsus* Turn. Caterpillars were common in Ben Gurr's garden above Moloata, Aug. 27. They were found on corn tassel, cucumber, squash, sweet potatoes, taro, tobacco and turnips.

Othreis fullonia (Clerck)

Three large caterpillars were found on leaves of *Erythrina* on the peninsula at Apia, Upolu, June 2. A chrysalis was found in a rolled leaf at the same place, from which the moth emerged June 12. At Afiamalu, Upolu, June 14, a small caterpillar was found on *Erythrina* leaf. It was reared to maturity, spinning up for pupation July 4, and the moth emerged July 26. When collected the small caterpillar was black. After 10 days it had grown to a length of 1½ inches; was mostly black with scattered white dots and other white marks on posterior segments; three pairs of conspicuous white spots on first three abdominal segments, the 2nd and 3rd have a black spot on ventral edge which in turn has a ventral, orange, lunate border. The caterpillar has a habit of resting with the anterior portion humped up and the head doubled back to abdominal prolegs, of which there are 4 pairs, the anterior pair imperfect. The posterior end is also raised from the leaf on which it rests with only the three pairs of perfect legs. The posterior end had a large blunt dorsal tubercle, reddish at apex.

Parallelia vitiensis (Butler)

A large caterpillar was found under loose bark of *Hibiscus tiliaceus*, apparently about to spin for pupation. Moth emerged July 1. Probably the caterpillar had fed on the foliage of the tree.

Cosmophila flava flava (Fab.)

One caterpillar collected on Hibiscus in garden at Casino Hotel, Apia, Upolu, June 3. Adult moth emerged June 18. One caterpillar on *Hibiscus tiliaceus* at Vaialua, Upolu, July 28. Moth emerged Aug. 16. One caterpillar on leaf of *Sida rhombifolia,* Afiamalu, Upolu, June 13. Moth emerged July 4.

Rusicada vulpina (Butler)

At Falefa Falls, Upolu, June 3, one prettily colored caterpillar was collected on *Hibiscus tiliaceus.* Caterpillar black with a light yellow longitudinal band a little to each side of dorsal line; head very pale brown. Moth emerged June 24.

Tiridata samoana (Butler)

Caterpillars were very abundant on an unidentified shrubby burr-weed along roadsides at Tapatapao, Upolu, July 21. One moth was reared. An ophionid was reared from one caterpillar.

Azazia rubricans (Boisd.)

A large green caterpillar was found on *Vigna marina* on the peninsula, Apia, Upolu, July 13. Adult moth emerged July 21. One caterpillar was found on the same plant at Falepuga. From it twenty *Apanteles* cocoons were formed, and the parasites issued Aug. 5 (*Apanteles expulsus* Turn.). *A. rubricans* was not previously recorded in Samoa.

Simplicia lautokiensis Prout

Caterpillars were found among dried leaves on a felled tree at Utulei, 700 ft. Tutuila, Aug. 24. One moth emerged.

Ophiuche ferriscitalis (Walk.)

Several larvae were collected on leaves of *Commelina nudiflora* at Malololelei, Apia, June 13 and 18. Also at Afiamalu, Upolu, June 14. One moth was reared; several were swept from the plant. The caterpillar is slender, green, with 3 pairs of abdominal prolegs.

Hyblaea sanguinea Gaede

Three caterpillars were found in spun-together leaves of *Premna taitensis* at the shoreline, Falepuga, Upolu, July 28. Two of them pupated, and moths emerged Aug. 10.

PYRALIDAE

THYRIDINAE

Brixia dialitha Tams

One leafroller larva on *Macaranga,* Amouli, 400 ft. Tutuila, Aug. 2. Moth emerged Aug. 18.

PHYCITINAE

Homoeosoma ephestidiella Hampson

The larvae feed in flower heads of *Ageratum conyzoides.* Were

found at Afiamalu, Upolu, June 14, 25 and July 3. Tapatapao, Upolu, July 21. Fagatoga, 300 ft., Tutuila, Aug. 28.

Cryptoblabes proleucella Hampson

Several larvae were found feeding on the sugar cane aleurodid, *Neomaskellia bergii* (Sign.), at Tapatapao, Upolu, July 16. The larvae were beneath a web which covered the aleurodid colony on which they fed. Five moths emerged July 29. Two larvae were found feeding similarly at Experimental Farm, Taputimu, Tutuila, Aug. 7. Two moths emerged Aug. 16 and 21.

Hypsipyla swezeyi Tams

Four plump whitish larvae were found in an old cacao pod in a plantation near Apia, Upolu, June 4. Moths emerged later and were spoiled. A little below Malololelei, Upolu, July 7, an old cacao pod had several larvae which had eaten all of the seeds. Two moths emerged July 17 and 18.

HYDROCAMPINAE

Bradina acrospila (Meyr.)

Leafroller caterpillars were common on a clump of *Wedelia biflora* by the shore at Falepuga, Upolu, July 28. Six moths emerged Aug. 1 to 5. Reared from the same plant at Breaker Point, Tutuila, Aug. 19. On the slope at north side of Pago Pago harbor, Tutuila, Aug. 6, larvae and pupae were found on the leaves of a green *Coleus* which was common. Four moths emerged Aug. 8 to 14; also two *Chalcis samoana* Fullaway Aug. 13 and 18 from pupae.

PYRAUSTINAE

Hymenia recurvalis (Fab.)

Larvae abundant on leaves of *Borreria ocimoides,* a weed in the garden of the Casino Hotel, Apia, Upolu, June 5.

Ercta ornatalis (Duponchel)

The small green larvae were found feeding on the under side of leaves of *Ipomoea pes-caprae,* eating off small spots, leaving the upper epidermis, on the peninsula at Apia, Upolu, July 13 and 14. Three moths emerged July 28 and 31. At Tapatapao, Upolu, July 21 and 23 moths were obtained from a large patch of *Ipomoea bona-nox* vines, and from a sweet potato patch, and undoubtedly the larvae fed on these two plants also.

Marasmia venilialis (Walk.)

Larvae collected in rolled leaves of the grass *Paspalum conjugatum* at Afiamalu, Upolu, July 3. Moths emerged July 20 and 23. Two moths reared from same grass at Tapatapao, Upolu, July 16. One moth reared from corn leaf, Sinaele, Upolu, July 27. Reared from Job's tears, Pago Pago, Tutuila, Aug. 10; Utulei, Tutuila, Aug. 17.

Marasmia trebiusalis (Walk.)

The larvae were very abundant as leafrollers on the grass *Oplismenus compositus* in several places: Malololelei, Upolu, June 18; Afiamalu, Upolu, July 3; Tapatapao, Upolu, July 16. A few moths were reared. One parasite was bred: *Apanteles samoanus* Fullaway.

Marasmia trapezalis (Guen.)

Larvae of this leafroller were found on *Miscanthus japonicus* at Pago Pago, Tutuila, Aug. 13, and Fagatoga, Tutuila, Aug. 25. A few moths were reared. One parasite was bred: *Apanteles samoanus* Fullaway.

Phostria oconnori Tams

One larva was found feeding between spun-together leaves of a large bean vine (*Strongylodon lucidus*) at Afiamalu, Upolu, June 19. The moth emerged July 11. More larvae were found at Afiamalu, June 30, from which four moths were reared.

Nacoleia diemenalis (Guen.)

Larvae were found abundant, feeding between spun-together leaves of *Vigna marina* on the peninsula, Apia, Upolu, July 13. Three moths emerged July 26 to 28. This leafroller was also found at Pago Pago, Tutuila, Aug. 16; Utulei, Tutuila, Aug. 17; Breaker Point, Tutuila, Aug. 19. A small tachinid fly was bred from one larva. (Undetermined.)

Nacoleia octasema (Meyr.)

This is the well-known banana scab moth. The work of the larvae in banana bunches was commonly noted. Sometimes the green bananas are eaten into when small and ruined. On larger fruit, gnawing of the skin causes a scabby appearance, though the fruit may ripen for use. On account of the foul appearance of injured banana bunches, the fruits are cut off individually and sorted before packing for shipment. The banana is one of the chief exports of Western Samoa. A cargo of about 10,000 cases goes to New Zealand twice per month. The cases are about like orange boxes and the green bananas are solidly packed in layers, regularly arranged.

Larvae were obtained at Malololelei, Upolu, June 18, and moths emerged July 13. Three larvae were collected from green bananas at the Experimental Farm, Taputimu, Tutuila, Aug. 7, from which moths were reared Aug. 19 to 25.

Nacoleia sp.

Two moths were reared from larvae in spun-together leaves of *Strongylodon lucidus,* Afiamalu, Upolu, June 30.

Sylepta sabinusalis (Walk.)

The caterpillars were common as leafrollers on *Cypholophus macrocephalus* on the reservoir trail, 800 ft., above Fagatoga, Tutuila, Aug. 3; pupae also collected. Six moths were reared Aug. 11

to 21. The parasite *Echthromorpha samoana* Cushman issued from one pupa and one *Chelonus vitiensis* Turn. was bred. Moths were also reared from *Pipturus argenteus* (?) on Afono trail, Tutuila, Aug. 1; Reservoir trail, Fagatoga, Tutuila, Aug. 3; Fagasa trail, Tutuila, Aug. 4. A pupa was obtained on *Pipturus* at Blunt's Point, from which *Chalcis samoana* Fullaway issued.

Sylepta derogata (Fab.)

Two moths were reared from leafrollers on Hibiscus in Casino Hotel garden at Apia, Upolu, June 3. The moths emerged June 21 and 24. Larvae were found on *Hibiscus tiliaceus* leaves at Tapatapao, Upolu, July 19 and at Falepuga, Upolu, July 28, but not reared. The rolled leaves produced by larvae of this moth were observed occasionally on Tutuila, at Amouli, Aug. 2, Pago Pago, Aug. 6, Blunt's Point, Aug. 17, but none reared. In one leaf roll at Pago Pago was a leaf cutter bee's nest, from which a *Megachile scutellata tutuilae* Perkins and Cheesman issued later.

Margaronia mysteris (Meyr.)

One pupa found between webbed leaves of *Strongylodon lucidus* at Afiamalu, Upolu, June 9. It died just before emerging, but had sufficiently developed as to disclose its identity. One moth was reared from larva on unidentified host plant at Tapatapao, Upolu, July 20.

Psara stultalis (Walk.)

Larvae were common in webbed leaves of *Coleus* at Malololelei, Upolu, June 18. Eight moths emerged July 4 to 14.

PTEROPHORIDAE

Platyptilia pusillidactyla Walk.

The larvae feed in flower heads of lantana. They were found at Apia, Upolu, June 2 on the ridge leading to Mt. Vaea; Afiamalu, Upolu, June 30; Tapatapao, Upolu, July 21; Satapuala, Upolu, July 28. A few moths were reared. This moth had been introduced from Fiji, a few years previously, but it had not yet been ascertained that it had become established.

Undetermined pterophorid

Was reared from larvae feeding on the newest leaves of *Trema orientalis viridis* at Utulei, 700 ft. Tutuila, Aug. 18. Two moths emerged Aug. 26 and Sept. 1.

EUCOSMIDAE

Spilonota holotephras Meyr.

The larva feeds in the webbed-together terminal undeveloped leaves of guava. It is sufficiently common as to check the growth of the plant and prevent its thriving. Larvae and pupae were collected at Apia, Upolu, on the ridge leading to Mt. Vaea, June 2;

Apia, June 5; Afiamalu, Upolu, June 8; Satapuala, Upolu, July 28; Amanave, Tutuila, Aug. 7. A few moths were reared.

Crocidosema plebiana Zeller

The larvae were found in buds and fruit of *Sida rhombifolia* at Afiamalu, Upolu, June 19.

Bactra microtripta Meyr.

Reared from larvae in seeds of *Desmodium umbellatum*, Goat Island, Naval Station, Tutuila, Aug. 11. The seeds are infested while on the plant. Eight moths were reared.

Argyroploce rhynchias (Meyr.)

Larvae were found eating seeds in green pods on *Erythrina* at Afiamalu, Upolu, June 12 and 26. Three moths emerged July 6 to 31. This species was not previously recorded in Samoa.

GELECHIADAE

Thiotricha oxyopis Meyr.

The larvae live in slender, cylindrical, upright, portable cases about 5 mm. long, and feed on the surface of *Macaranga* leaves. They are mostly on the lower surface and may be so numerous as to nearly skeletonize the leaf. Pupation takes place within the case which remains attached to the leaf. These cases were found very numerous in several localities: Apia, Upolu, on the ridge leading to Mt. Vaea, June 2; Falepuga, Upolu, July 28; Fagatoga, Tutuila, Aug. 12; Utulei, Tutuila, Aug. 18; Mt. Pioa, 800 ft., Tutuila, Aug. 29. Several moths were reared. Also parasites: *Apanteles* (?).

Thiotricha strophiacma Meyr.

Larvae of this moth feed on the leaves of *Terminalia catappa*. They were found very numerous on leaves of a small tree at Falefa Falls, Upolu, June 3. Each larva feeds beneath a shield made by cutting out a roundish oval piece of the leaf which it moves from place to place, a larger shield being cut from time to time accommodating the growth of the larva. The ultimate shields are 11 by 8 mm. in size. About a score of moths were reared June 19 to 30. As indicating how abundant the larvae may be, at Afiamalu, Upolu, June 30, in two *Terminalia* leaves there were respectively 21 and 25 of the holes where shields had been cut out for use by the larvae.

Thiotricha symphoracma Meyr. (?)

Larvae of this moth were found very abundant on leaves of a small endemic palm (*Balaka* sp.) at Afiamalu, Upolu, June 9. Each larva was in a slender case projecting from a circular base of webbed frass beneath which feeding was done on the surface of the leaf. Thirty moths emerged June 22 to July 10. Practically wherever this palm was found, the work of these larvae was seen on the leaves: several places near Afiamalu, June 13, 27, 30; Tiavi, Upolu, July 9; Tapatapao, July 13, 20, 21.

AGONOXENIDAE

Agonoxena argaula Meyr.

This moth is a coconut pest. The larvae feed singly on the lower side of the leaflet beneath a slight web, and produce short, narrow dead streaks where they have eaten off the under surface of the leaflet. These lie longitudinally and may be up to a half inch in length. There are many of them and with the aging of the leaflet the dead upper epidermis rots away so that the leaf has the appearance of being riddled with the slit-like holes. Only the newer leaves on the trees are free from these injuries, but the young larvae begin feeding on the new leaves soon after they are fully expanded. In every locality visited the coconut trees showed injury by these larvae. The cocoon is white, made on the surface of the leaf. It is broad, oval and flat, and often made on leaves of other plants and trees adjacent to or beneath coconut trees. A few moths were reared from various localities: Afiamalu, Upolu, June 30; Apia, Upolu, July 16; Amouli, Tutuila, Aug. 2; Pago Pago, Tutuila, Aug. 10 and 13.

A large endemic palm *Clinostigma oncorhyncha* is also injured by larvae of this moth. All of the older leaves showing the results of their activities. Moths were reared from material collected at Afiamalu, Upolu, June 12, 27. Their work was also seen at Tiavi, Upolu, June 21. Parasites were also reared (*Apanteles agonoxenae* Fullaway).

COSMOPTERYGIDAE

Cosmopteryx mimeticus Meyr.

The larvae of this beautiful delicate little moth are leafminers in nut grass (*Cyperus rotundus*). They mine the tips of the leaves, working towards the base so far as necessary for their growth. Pupation takes place within the mine. Reared only from Aua, Tutuila, Aug. 29. The moth however was collected at several localities on Upolu.

Cosmopteryx dulcivora Meyr.

This delicate little moth is the midrib miner of sugar cane. The larva is slender, yellowish and bores for a considerable distance longitudinally in the midrib, often in a zigzag manner. The midrib is rendered useless and turns a reddish color. Affected leaves are conspicuous and were found in a number of localities: Tapatapao, Upolu, July 16-23; Pago Pago, Tutuila, Aug. 16; Aua, Tutuila, Aug. 29; Moloata, Tutuila, Aug. 27. Larvae and pupae were collected, and the moth reared. It was not recorded in "Insects of Samoa".

Trissodoris honorariella (Walsm.)

The *Pandanus* leafminer is recorded under this name in "Insects of Samoa". The very elongate whitish larvae mine in dead dry *Pandanus* leaves. When full grown, oval pieces are cut including

both upper and lower epidermis of the leaf and pupation takes place within the case made by the two pieces fastened together. The case is about 10 x 4 mm. It may be drawn into the mine between the layers of epidermis of the leaf, or fall and be caught amongst trash in the axils of leaves, or to the ground. At Tiavi, Upolu, June 21 and Afiamalu, Upolu, June 27, the larvae were found mining in green leaves. These were on the same trees where larvae were working in the dry leaves. Not sufficient specimens were reared to determine whether two different species are involved in the different feeding habits. When feeding in the dead leaf there is no evidence of the location of the mine other than the hole which is made for the case in which to pupate. Whereas, the larva eating in a green leaf makes a conspicuous blotch mine, and frass is extruded through holes in the dead epidermis, so that these dead spots on the leaf are well covered with frass, and thus conspicuous. The cases for pupation are made from the dead epidermis of the mine so that there is the oval hole through the leaf in the position of the mine. As many as 15 of these holes were counted in a single dead leaf. At Lake Lanutoo, Upolu, July 22, and Satapuala, Upolu, July 28; Leone, Tutuila, Aug. 7, and Tutuila, near Poyer School, Aug. 16, dry leaves were found with the characteristic holes, but there was no evidence of larvae having been working in green leaves. A chalcidoid pupa was found in one mine in green leaf at Afiamalu (it died) and several mines had exit holes where parasites had issued.

Trissodoris sp.

A much smaller species with wings mostly black was reared from a small pupal case among others collected near the Poyer School, Tutuila, Aug. 16.

Trissodoris sp.

At Fagatoga, 840 ft., Tutuila, Aug. 25 many *Freycinetia* leaves were found with mines (in green leaves only) similar to those in *Pandanus,* and it is no doubt a related species, but none was reared. The mines are longitudinal in the green leaves, and the holes cut in the mines for making the pupal cases were slightly smaller than those in *Pandanus* leaves, about 9 x 4 mm. In 12 leaves collected for examination, only one mine had a larva, which was 6 mm. long. Seven mines had exit holes of some parasite, probably chalcidoid. The same leaf mines were found in *Freycinetia* leaves at Moloata, 1000 ft., Tutuila, Aug. 27, and Mt. Pioa, 1000 ft., Tutuila, Aug. 29.

HELIODINIDAE

Pachyrhabda amianta Meyr.

Larvae of this moth are rather common on the fronds of *Asplenium nidus* in all places where the bird's nest fern is found: Falefa Falls, Upolu, June 3; Afiamalu, Upolu, July 4; Tapatapao, Upolu, July 13; Falepuga, Upolu, July 28; Amouli, Tutuila, Aug. 2; reser-

voir trail, Fagatoga, Tutuila, Aug. 3. The larva feeds beneath a circular disk of webbed-together sporangia about 8 mm. in diameter. Apparently they feed mainly on the sporangia. Often a dozen were found on a single frond, and always on fronds from which the sporangia had been eaten, or shed. Sixteen moths issued from material collected in various places. Seven *Apanteles hyblaeae* Wilk. and two *Mesochorus* sp. were also reared as parasites of the larvae.

Pachyrhabda antinoma Meyr.

Larvae were very numerous feeding on the spores of a fern (possibly *Polpodium polynesicum*) at Afiamalu, Upolu, June 11. They fed beneath slight webs. Cocoons were collected on the fronds and about a score of moths emerged June 30 to July 15. Two parasites issued also: *Tetrastichus* sp.

GLYPHIPTERYGIDAE

Brenthia trimachaera Meyr.

Numerous white spindle-shaped cocoons were found on leaves of *Trema orientalis viridis* (?) at Utulei, Tutuila, 700 ft., June 18, and 100 ft., June 21. From cocoons collected, 15 moths emerged Aug. 22 to 30. At Pago Pago, Tutuila, 600 ft., Aug. 22, the larvae were found feeding on the underside of the leaves of the same plant. They were feeding individually in scattered spots, and the cocoons were made away from the eaten area, and always on the underside of leaf.

Brenthia catenata Meyr.

Larvae and cocoons were abundant on leaves of a wild bean vine (possibly *Strongylodon lucidus*) on the Afono Trail above Aua, Tutuila, Aug. 1. The cocoons were white, spindle-shaped as in the previous species. From material collected, 10 moths were reared Aug. 6 to 14.

GRACILARIADAE

Acrocercops homalacta Meyr.

Leafminer in *Operculina turpethum*. Mines collected at Fagatoga, Tutuila, Aug. 3. Seven moths were reared Aug. 15 to 18. Also four parasites (*Apanteles operculinae* Fullaway). The mines were observed also at Fagasa Trail, Aug. 4, and Blunt's Point, Aug. 21. At Ben Gurr's garden, Moloata, Tutuila, Aug. 27, mines were abundant in sweet potato leaves. None reared, but moths were collected by sweeping.

Acrocercops sp.

Leafminers in *Hibiscus tiliaceus*, the blotch mine usually being located near the base of the leaf and often next to the midrib. It occurs practically everywhere that its host plant is found in Samoa. Material was collected and moths reared from the following: Tapatapao, Upolu, July 22; Sinaele, Upolu, July 27; Pago Pago, Tutu-

ila, Aug. 6; Blunt's Point, Tutuila, Aug. 17. From the latter place one parasite (*Tetrastichus* sp.) was reared. This *Acrocercops* is closely related to *homalacta*.

Acrocercops sp.

Another closely related species was reared from an unknown host. The mines are conspicuous by callus-like places where the larvae have lived during the latter part of their life. These are located on the lateral veins of the leaf, and often 3 or 4 pairs symmetrically arranged. Moths were reared from mines collected at Afiamalu, Upolu, July 3 and 8; Tapatapao, Upolu, July 19. A parasite was also reared from the latter place (*Tetrastichus* sp.).

Acrocercops sp.

A bean leafminer. It occurred abundantly in leaves of *Vigna marina* at Apia, Upolu, June 2 and July 13. A few moths were reared. The larvae are bright red and can be seen through the dead upper epidermis beneath which they feed and loosen so that it gives the appearance of a dead blotch. There may be several per leaf, so that the whole upper surface appears dead. Moths were also reared from mines in leaves of *Cassia occidentalis* at Apia, Upolu, July 13, the moths issuing July 17 to 23.

Acrocercops spp.

Several other species of leafminers, probably of this genus, were reared from undetermined host plants, and the species of the moths also are still undetermined.

LYONETIADAE

Decadarchis minuscula (Walsm.)

Larvae feeding in old cacao pods near Apia, Upolu, June 4. Seven *Melittobiopsis ereunetiphila* Timb. issued from the same material. They probably had been parasitic on the *minuscula* larvae, as that is their habit in Hawaii, where they feed mostly on larvae of *Decadarchis flavistriata* (Walsm.).

Decadarchis simulans (Butl.)

Larvae and cocoons were very numerous under loose bark of a large log of an introduced leguminous tree resembling *Albizzia moluccana*, at Tapatapao, Upolu, July 19. Several moths emerged. Although Meyrick in "Insects of Samoa", places this species in *Decadarchis*, it has the wing venation which he describes for his genus *Erechtias*.

TINEIDAE

Trachycentra calamias Meyr.

At Afiamalu, Upolu, July 10, larvae of this moth were found feeding in the core of a coconut tree top which was damaged by the rhinoceros beetle. Some of the larvae were boring into the living

tissues of the mass of undeveloped leaves, free without cases. Other larvae were feeding in the mass of rotting tissues, and those which were apparently the older ones were in brown cases many of which were covered with fibers placed on longitudinally and overlapping like thatch. Pupation took place within these shaggy cases. Seventeen moths emerged July 20 to Aug. 14. Larval cases were also found in rotten banana stem at Malololelei, Upolu, June 18, and moths emerged July 23-31. At Afiamalu, June 27, one of the larval cases was found in the petiole of a dead banana leaf. At Tapatapao, Upolu, July 18, a larval case was found beneath bark of an *Erythrina* log. The moth emerged Aug. 25.

Bedellia sp.

At Tapatapao, Upolu, July 23, mines were found in sweet potato leaves, from which 6 moths were reared July 29 to Aug. 10. They were the same as were caught by sweeping on the sweet potato vines. The larvae had the characteristic habit of *Bedellia* larvae of migrating from mine to mine, or leaf to leaf, and the pupa is formed outside the mine among a few strands of web in a secluded place like a crumpled part of a leaf, or in axil of veins on the lower side of leaf. The larvae were different from those of the Hawaiian sweet potato leafminer, *Bedellia orchilella* Busck. Purplish brown, with lateral white spots on abdominal segments, 1, 2, 4, 5; long and narrow, about 5 mm. It was not found in any other locality. No *Bedellia* has been previously reported from Samoa.

SUMMARY OF FAMILIES

7 Butterflies	1 Agonoxenidae
3 Sphingidae	5 Cosmopterygidae
2 Geometridae	2 Heliodinidae
15 Agrotidae	2 Glyphipterygidae
18 Pyralidae	4 Gracilaridae
2 Pterophoridae	2 Lyonetiadae
4 Eucosmidae	2 Tineidae
3 Gelechiadae	—
	72 Total species

A New Species of Oechalia from Oahu (Pentatomidae, Hemiptera)

BY ROBERT L. USINGER
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(Presented by O. H. Swezey at the meeting of November 10, 1941)

Since the appearance of my revision of the genus *Oechalia*,* eighty-four Hawaiian specimens have been received through Mr. H. G. Barber from the United States National Museum. In general, this material serves to substantiate the conclusions reached in 1941 regarding the distribution and limits of variation of the species of *Oechalia*. Of greatest interest are the five additional specimens of *kaonohi* Kirkaldy from Niulii, Hawaii, June 6, 1903, collected by Van Dine, and two specimens of a very distinct new species described below.

Oechalia sinuata Usinger, new species

Allied to *ferruginea* Usinger from the island of Hawaii but with strongly sinuate antero-lateral margins of pronotum, sharply contrasting pale and dark areas on the scutellum, and a short, broad body form.

Head slightly broader across eyes than long, 42::39; distinctly shorter than pronotum on median line, 39::46. Antennae a little longer than combined lengths of head and pronotum, 90::85; proportion of segments one to five as 9:21:19:22:19. Rostrum reaching to hind margins of middle coxae; proportion of segments one to four as 18:20:16:16. Pronotum two and one-half times as broad across humeri as long, 119:46, the humeri moderately produced, bluntly angulate apically, extending nearly one-eleventh the total width of pronotum beyond bases of hemelytra, their front margins strongly arched and elevated above level of pronotal disk; antero-lateral margins concave and level at middle, then convexly arcuate, subdepressed and serrate on anterior half. Scutellum, hemelytra, connexivum, and most of under surface as in allied species. Abdominal prolongation very long, reaching to level of front coxae, bent downward beyond middle. Femora beset with scattered erect hairs about half as long as thickness of femora.

Genital plates of male small, one-fourth the total width of genital cup, 6::24; about two-thirds as long as wide, concave at middle of dorsal margin, rounded on inner and ventral margins, feebly concave and distinctly toothed on outer margin with the dorso-ectal angle feebly produced; surface feebly concave and distinctly tuberculate. Width across tips of harpagonal arms about three-fourths the width of genital plates, 9::13. Female genital plates as in related species.

Color ferrugineous with dark fuscous punctures, head markings, basal and subapical thirds of scutellum, and bases of connexival segments. Subdepressed portions of antero-lateral margins of pronotum and middle and apex of scutellum ivory-white interrupted by fuscous punctures. Under surface ferrugineous with abdominal prolongation, coxae, apices of femora and bases of tibiae ochraceous to fulvous, bases of femora, second segment of rostrum

* Usinger, R. L. 1941. The genus Oechalia. Proc. Hawaiian Ent. Society, 11:59-93, 8 figs.

and claws nearly black, middle of femora brown mottled with darker brown spots.

Size: male, length 9 1/2 mm., width (across humeri) 5 2/3 mm.; female, length 12 1/2 mm., width (across humeri) 7 mm.

Holotype, male, Mt. Kaala, Oahu, July 4, 1916, on "Ohia lehua" (*Metrosideros*). No collector is indicated but the locality label is in the handwriting of P. H. Timberlake. The specimen is from the collection of J. C. Bridwell and is in the United States National Museum. A female is at hand with the left hemelytron and a large portion of the left side of the abdomen eaten away by dermestids. It bears the printed labels of Bridwell indicating that it was collected at the same time and place as the holotype. This specimen likewise bears no collector's label.

Sinuata differs from all other described Oechalias in type of maculation and in degree of sinuation of antero-lateral pronotal margins. It is undoubtedly close to *ferruginea,* the only other species in which the second antennal segment is longer than the fifth. The ferrugineous ground color and long abdominal prolongation are additional recognition characters for this pair of species. The all important comparison of male genital characters of *sinuata* and *ferruginea* must await the discovery of males of *ferruginea* on the island of Hawaii.

A New Eucnemid Beetle from New Caledonia

BY R. H. VAN ZWALUWENBURG
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(Presented at the meeting of October 13, 1941)

The eucnemid genus *Subprotelater* was established by Fleutiaux in 1916 (Philippine Journal of Science, xi, p. 387) for his *S. bakeri* from Luzon; later he described a second species, *S. guttatus* (Philippine Journal of Science, xv, p. 445, 1919) from Singapore. The species here described is the third known of this interesting genus. I take pleasure in dedicating the species to its discoverer, Dr. Francis X. Williams, who found it during his four-months' stay in New Caledonia in 1940.

Subprotelater williamsi n. sp.

Elongate, subparallel (see fig. 1). Entirely black save for the ferruginous tarsi and the following four yellowish-white areas on each elytron: (1) the smallest of the four, a subcordate spot with its point directed backward, occupying intervals 3 to 5 inclusive, and all but attaining the basal margin of the wingcover; (2) an elongate marking on intervals 3 and 4, about three times as long as wide, its hind margin terminating at about the middle of the elytron; (3) a more or less round spot on intervals 7, 8 and 9, its anterior margin a little forward of the fore-margin of the elongate spot described above; and (4) a somewhat larger, more or less oval, area on intervals 4, 5, 6, 7 and 8, at about the posterior two-thirds of the wingcover. The basal spot is tumid and there is no trace of striae crossing it; the other light-colored areas are flattened with the striae plainly indicated across their surface. Pubescence fine, barely visible; black over most of the upper surface of the body, pallid on the whitish areas, grayish on the underside of the body.

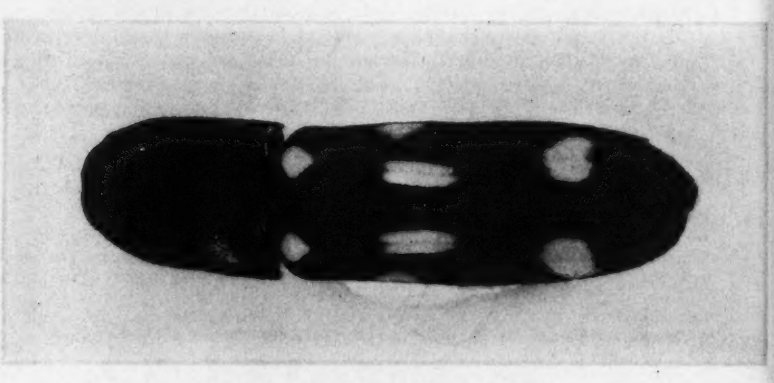
Head strongly channeled medianly from near the occiput, the groove lessening in depth as it approaches the epistoma; punctation moderately fine and deep, somewhat more closely spaced anteriorly. Antennae, submoniliform, short, not attaining hind angles of the prothorax; 2nd segment short, about one-half length of 3rd; 3rd and 4th subequal; 4th to 10th gradually diminishing in length, with a fine, median carina along middle of outer face; 11th about one-half as long again as 10th.

Prothorax longer than wide; sides subparallel, narrowed forward from anterior one-fourth. Pronotum with frontal margin simple; shallowly impressed medianly, with two vague impressions on either side before middle; sides sharply declivous and basal declivity abrupt, disc depressed; hind angles directed straight backward, strongly unicarinate; punctation fairly deep, coarse, uniform. Prosternum wide, somewhat tumid, punctation about as on pronotum, but somewhat sparser; mucro straight, slightly depressed behind fore coxae. Pleuro-sternal sutures open along their posterior three-fourths, resulting in deep grooves in which the anterior tarsi are received. Antennal groves marginal, deep, finely delimited along inner edge; failing to attain tips of hind prothoracic angles by about the length of the angles themselves.

Scutellum elongate, sharply declivous anteriorly, less so on apical one-half; convex; subrugosely punctate.

Elytra about twice as long as head and prothorax; sides subparallel, narrowed from about posterior one-third to the conjointly rounded apices; punctate-striate, intervals more or less convex, especially toward base, subrugosely punctate. Hind coxal plates untoothed on hind margin, widening laterad, with the lateral margin wider than the episternum. Legs short; tarsi and claws simple.

Length 4.5 mm.; width 1.25 mm.



Subprotelater williamsi, n. sp. × 20.

Described from a type specimen of unknown sex, taken by Dr. Williams, August 28, 1940 on the outskirts of Noumea, New Caledonia, resting on bark of "niaouli" tree (*Melaleuca leucodendron* Linn.) at about 300 feet above sea-level. The type is deposited in the collection of the Hawaiian Sugar Planters' Association Experiment Station in Honolulu.

Ampulex Compressa (Fabr.), A Cockroach-Hunting Wasp Introduced from New Caledonia Into Hawaii

BY FRANCIS X. WILLIAMS
Experiment Station, H.S.P.A.

(Presented at the meeting of December 22, 1941)

In May 1940 the Experiment Station of the Hawaiian Sugar Planters' Association sent the writer to New Caledonia to make a survey of the economic insects—with special reference to those affecting sugar cane—of that large island. With the knowledge thus gained, Hawaii would be forewarned and thus forearmed against entry into the territory—particularly by the swift clipper ships—of injurious forms. Pan American Airways' clippers to and from New Zealand stop at New Caledonia and thus there is danger of bringing in new harmful insects.

In going over a catalogue of insects known to occur in New Caledonia and kindly furnished the Experiment Station by Mr. E. C. Zimmerman, entomologist of the Bernice P. Bishop Museum, Honolulu, the wasp *Ampulex compressa* (Fabricius) is listed by Dr. R. E. Turner [11*], as taken in Noumea, New Caledonia, in January and February. Here was a fine opportunity to import this beneficial insect into the Hawaiian Islands.

Ampulex compressa is a large, beautiful wasp with a shining, blue-green body and with the femora or thighs of the second and third pairs of legs red. The female is about 22 millimeters or between ¾ of an inch and an inch in length. The male averages smaller and lacks the sting. It is perhaps the most widely distributed species of the large and chiefly tropical genus *Ampulex,* Bingham [1] giving its range as: "Throughout India, Burma, Ceylon"—where it is endemic—"and extending into Africa and to China." It is also known to inhabit St. Helena and some of the islands of the Indian Ocean, as well as New Caledonia in the southwest Pacific.

The known literature referring to the habits of *Ampulex compressa* dates from the year 1742, when Reamur [6] relates the observation of a certain M. Cossigni on this wasp, the "guêpe ichneumon," as noted in Mauritius (Ile de France). H. Lucas [3] in the year 1879 refers to the cocoon of *Ampulex* from New Caledonia, as encased in the remains of *Blatta americana.* In Burma, Bingham [1] states that this wasp frequently enters houses in search of cockroaches. Maxwell-Lefroy [4] has observed *Ampulex compressa*

* Numbers refer to the list of papers in the Literature.

in Pusa, India, where it is purely arboreal in habit, its chief haunts being the trunks of old "Peepuls" (*Ficus religiosa*), a common banyan or strangling fig, and fig trees which possess numerous holes and chinks—such places being likely to harbor cockroaches. This environment rather than the establishments of man is no doubt its original habitat—insects considerably antedating man—and the adaptable *Ampulex compressa,* where many of its relatives are strictly woodland species, has followed its cockroach prey in and about buildings, walls, etc. And this semi-domiciliary habit may largely account for the wide geographical range of the wasp, and at any rate, adds to its value as an introduction.

Other species of *Ampulex* have much the same habits as *Ampulex compressa.* Sonnerat [10] writes of the habits of *A. sonnerati* Kohl in the suburbs of Manila, Philippine Islands. This insect, "la mouche bleue" stings cockroaches to partial paralysis and stores them in crevices which it stoppers with debris. In West Africa, *Ampulex compressiventris* Guer. (= *A. siberica* Sauss.) enters houses in search of its prey (Perkins, fide Sharp [8]). Hingston [2] gives an excellent account of *Ampulex assimilis* Kohl in the groves of date palms about Bagdad. Its particular cockroach prey is *Shelfordia tartara* Sauss. *Ampulex amoena* Strand (= *A. novarae* Sauss.) in Formosa stores immature individuals of the two common large cockroaches, *Periplaneta americana* (Linn.) and *P. australasiae* (Fab.) (Sonan [9]). *Ampulex fasciatus* Jurine, a small blackish European species preys upon *Ectobia livida* (Fabr.), a suitably small cockroach [5]. *Ampulex caniculatus* Say, scarcely half an inch long and related to *A. fasciatus* was studied at some length by the writer [12] while stationed one summer at Webster Groves, Missouri. The wasp was successfully bred in a quart jar. Its prey was *Parcoblatta virginica* (Brunner), a common endemic wood roach. The experience gained in rearing this temperate zone *Ampulex* served the writer in good stead while working with *Ampulex compressa,* the well known "cantharide"† of New Caledonia.

A wasp so well known as *Ampulex compressa* could not fail to draw recognition from entomologists as a beneficial insect worthy of introduction into other tropical countries, and I have in mind the report of Mr. H. W. Simmonds [7]. When Mr. Simmonds was in Mauritius in 1939 working on enemies of the rhinoceros beetle (*Oryctes rhinoceros* L.) for importation into Samoa, he observed *Ampulex compressa* there and advised its introduction into Fiji. Unfortunately the advent of the cold season prevented its introduction during his stay in Mauritius. He did observe, however, that, based on a single pair of *Ampulex,* the female wasp was very long

† This is a misnomer; the name cantharide properly applies to one or more species of "blister beetles" (Cantharidae) found elsewhere. But both wasp and beetle have in common a metallic blue or green brilliance.

lived, surviving a confinement of 80 days. The male lived but a few days.

When Mrs. Williams and I arrived at Noumea, New Caledonia, on July 3, 1940, it was the cool season of the year, and while insects in general were to be found in plenty, certain species including the large black wasp, *Chlorion fumipennis* (Smith), the mud wasps *Sceliphron hemipterum* (Fabr.), *Rygchium haemorrhoidale,* var. *alecto* Lep., and *Odynerus caledonicus* Sauss., some butterflies and Orthoptera and many beetles of large size and conspicuous habits, were nearly or quite absent. And the "cantharide" or *Ampulex compressa* was nowhere to be found. But it was well known to the inhabitants and appreciated by them as a beautiful and useful insect, and later, Mrs. Williams, who took great interest in this scintillating blue-green insect very aptly named it the "jewel wasp" [13]. On the other hand, large *Periplaneta* cockroaches, the prey of jewel wasp, were abundant.

Slowly, it seemed, the season became more favorable for insect life, and as ever, a sharp lookout was kept for the desired wasp. Kitchen surroundings and gardens in and about Noumea were searched from time to time without success. But finally, on September 29, two female *Ampulex* were observed in the garden of the Hotel du Pacifique in Noumea. I did not succeed in capturing either. But on October 11, immediately following our return from a 10-day trip to the east coast of the island, a third specimen, also a female, was seen on the garden wall of the hotel. By a rather ill-aimed vigorous stroke of the net the prize was captured but in so doing one of its mandibles was broken off, thus rendering the wasp quite useless for dealing with her cockroach prey. On October 15, while we were having lunch in the hotel, a fine large female *Ampulex* appeared at a dining room window. She was hastily grabbed up in a handkerchief and safely placed in a jar in our laboratory.

Up to November 12, when we left New Caledonia by Pan American Airways plane for Honolulu via Canton Island, I was able to secure but 2 additional female *Ampulex.* These, as well as several males, were caught on October 17 and 21, on the trunk of a coconut palm growing in Mr. Lee Johnson's garden in Noumea and where through his kindness I made many collections and observations on insects of economic importance. To facilitate the capture of these wasps, honey was smeared on the palm trunk and this attracted one female and several males. The latter appeared the more frequent and could be seen running up the trunks of palms. It was evident, however, that these insects were only beginning to issue from their cocoons, but everyone said that later on, in the summertime, the "cantharide" would be abundant.

The three female wasps, of October 15, 17 and 21 respectively, were placed in separate glass gallon jars. *Ampulex* are quarrelsome creatures. The jars were laid on their sides in the laboratory table by a window and a piece of rough paper spread within on their lower sides. After some experimenting, a tube of corrugated cardboard—the corrugations on the outer periphery—about 3¾ inches long by ¾ inch internal diameter and stoppered at one end, was found suitable as a nest hole for *Ampulex*. Small debris, such as cut up cardboard, and portions of twigs, were strewn on the paper-covered floor of the jar. This debris was to be used by the wasp in stopping up the stored tube. The wasps were fed with honey.

Unlike the small rather unafraid *Ampulex* (*Rhinopsis*) *caniculatus* with which I experimented in Missouri, the more active *Ampulex compressa* was easily frightened and addicted to flying and of thus striking her head against the glass prison. Nevertheless, these large wasps, becoming somewhat tamer, survived their imprisonment in the one—and later the several—gallon jars, normally for several months.

As prey for the wasp a supply of *Periplaneta americana* (Linn.), the ordinary large house (and ship) cockroach of all tropical countries, was soon assured. A goodly number was collected in the tiny lazaret of "Les Trois Amis", a powered ketch moored at the waterfront. Larger quantities were later secured from a hotel kitchen.

At the rate of one, or occasionally two, partly grown to mature cockroaches were offered daily to each wasp. As a rule, *Ampulex* attacks the cockroach soon after the latter's introduction into the jar. The wasp then becoming very alert and with antennae directed towards her intended victim approaches it from the side in front and with a short lightning leap, seizes the edge of the pronotal plate with her beaklike clypeus and labrum above and the curved chisel-like mandibles pressing into the membrane beneath. Immediately directing her flexible abdomen forward and underneath the cockroach's thorax, she extends the point of her abdomen in search of a vital place in which to plunge her sting (Fig. 1). The cockroach now thoroughly frightened, struggles furiously, twisting, straining

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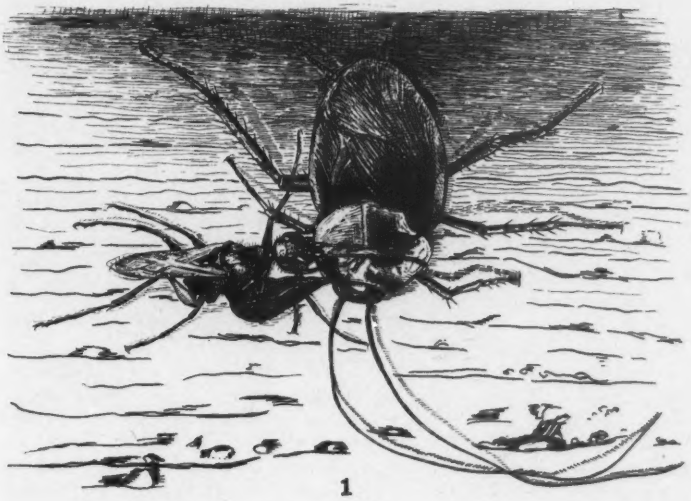
AMPULEX COMPRESSA

Plate V

1. The wasp stinging the cockroach (*Periplaneta americana*) in the throat. Enlarged.
2. Head of wasp to show the beak formed by the clypeus and labrum, and the chisel-edged mandibles.
3. *Periplaneta americana*, mesopleural region to show coxa bearing the wasp egg at basal end. Dotted areas A and B show membranes through which the wasp grub bites its way into the interior of the cockroach. The membrane at A seems the more frequently used of the two.
4. *Periplaneta americana*, from side, to show wasp's egg at A.



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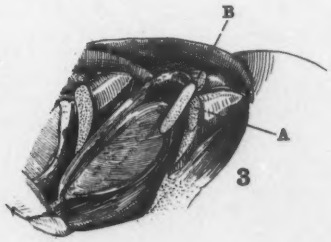

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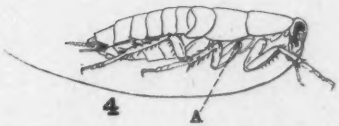

4

Ampulex compressa.

and describing short jerky circles, parrying with its legs, and striving particularly to tuck in its chin so that the tenaciously clinging wasp will not sting its throat. This struggle though often very rough on the aggressor, so often much the smaller of the two, is usually of no avail to the cockroach. It receives a sting in the thorax, its struggles become more feeble, and as *Ampulex* thrusts her sting deep into its throat the head is thereby forced outwards on a membranous neck. After a few moments of injecting the poison the wasp releases her hold and now backs off to view her work alertly. She may even grasp the cockroach and make pretense at dragging it away, but usually leaves it in place—a wretched spectacle, head down and helpless though not immobile and later regaining considerable activity.

The wasp now cleanses herself after the battle with the malodorous giant, and we note that the latter also grooms itself, passing its antennae through the mouth parts and reaching down to lick its legs.

Nesting operations proceed slowly. *Ampulex* discovers the cardboard tube and she enters and explores it. Then after a while she approaches her somewhat dazed victim and, grasping one of its antennae close to the base, in the tip of her mandibles, draws it through them to perhaps a little less than its middle length when, with a marked effort, characterized by a downbent head and often a quivering body, she severs or attempts to sever it. The other antenna is likewise dealt with. Several attempts may be necessary for this amputation. Frequently the wasp draws the cockroach's antennae through her jaws for their entire length. Where many cockroaches have been operated on by the wasp, the portions of their antennae conspicuously strew the paper-laid floor. More delay follows. Finally, after an hour or so, *Ampulex,* having assured her-

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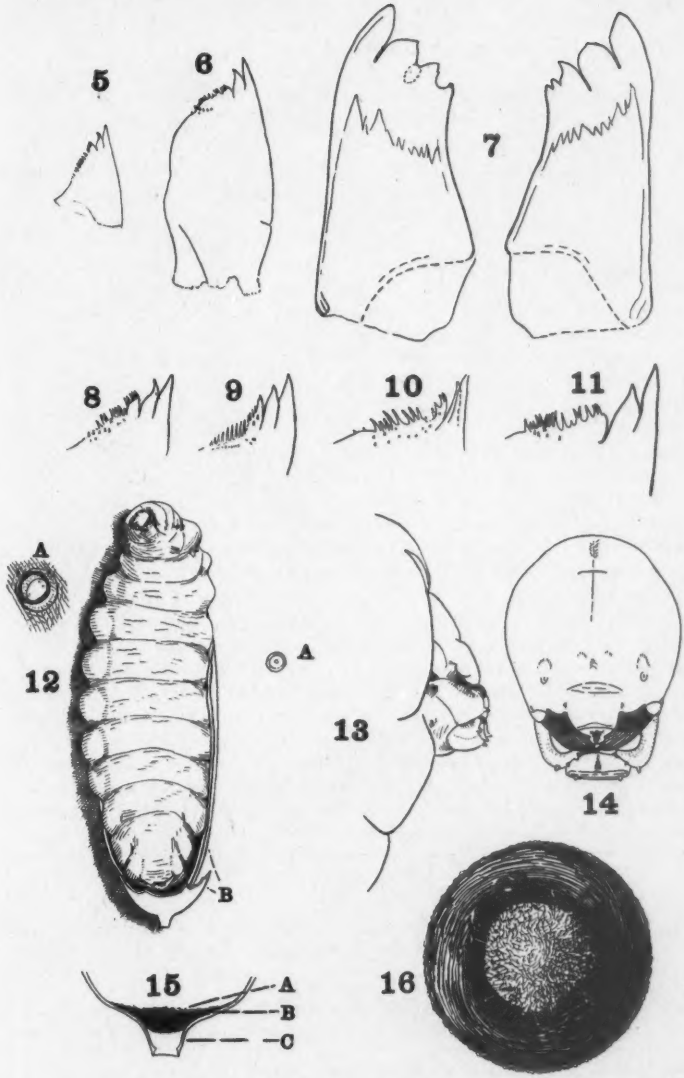
Plate VI

5. Mandible, 1st stage larva.
6. Mandible, 4th stage larva.
7. Mandible, pair, 5th or last stage, from larva in cocoon. Figs. 5, 6 and 7 all to same scale.
8-11. Mandibles—to show their toothed extremity. 1st to 4th stage. All are to same scale, but the magnification is higher than Figs. 5, 6 and 7. The 3rd stage (Fig. 10) shows mandible with the large teeth somewhat out of plane.
12. Full-fed resting larva, dissected from cocoon cask. A, spiracle detached and greatly enlarged. B, remnant of cask.
13. Full-fed larva, head and part of prothorax, side view. A, first spiracle.
14. Full-fed larva, head, front view.
15. Cocoon, inner cask divested of silken envelope; anterior end, from side, to show, edge on; A, the interior silken mat; B, the hard leathery layer; C, the nipple-like tube to exterior.
16. Same as 15, looking towards anterior end, from within. The central silken mat is conspicuous.



Ampulex compressa

self of the suitability of the corrugated tube as a storage receptacle for her prey, approaches the latter, and, grasping it by the very sensitive base of one antenna, and, in several starts and stops, at last backs into the tube dragging the cockroach in after her.

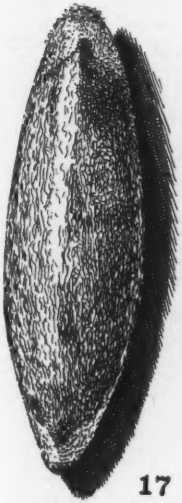
She remains in the tube for a short time to glue a delicate white egg about two millimeters in length along one of the cockroach's mid-coxal plates, as illustrated. In this position the egg can hardly be dislodged by any leg movement. The thicker extremity of the egg touches, or at least extends very near one of the two delicate membranous areas that help hinge the leg to the thorax (Fig. 3, A and B).

Issuing alertly from her stored tube, *Ampulex* soon avails herself of the small bits of debris lying about. She grasps a piece in her jaws and walking into the tube lodges it against or near the imprisoned cockroach. This performance is briskly repeated again and again. *Ampulex* often emits a little squeak as she securely packs in the debris that quickly fills up the tube and thereby imprisons her fairly active victim. Rarely such a victim succeeds in breaking through this barrier, although if properly parasitized, the young wasp may successfully develop on its host at large. If for some reason the wasp's egg fails to hatch, or the grub dies very young, the cockroach may survive for weeks.

There are variations in all these nesting activities, although their sequence remains the same. Sometimes the wasp attacks the cockroach when the latter is quiet; or she may, by digs of her mandibles first spur it into activity. Very frequently she pursues her intended victim, even flying after it. The fact that some sort of pause seems necessary to allow the wasp to get in the proper sidewise position to seize the cockroach, gives the latter some advantage in its flight. Sometimes *Ampulex* may grasp her prey too far forward, or especially too far to the rear to effectively use her sting; in such cases the wasp may release her hold for a better grip. As a rule the wasp will not attack a cockroach that is struggling on its back. But on one occasion a very old female (127 days) attacked one such—a not too vigorous cockroach that she had vainly and wearily pursued. Here she gripped her prey somewhere at the end of the clypeus and then length to length of the prostrate insect set about stinging it.

Plate VII

17. Wasp cocoon. Through the outer covering of silk may be faintly seen the nipple-like ends of the interior cask. Length 26 mm. Large specimen.
18. Wasp pupa; freshly formed. Length 16.2 mm.
19. The dead and dried cockroach, *Periplaneta americana*, that contains a hatched Ampulex cocoon. Perforation indicates where the wasp has issued. Length 37 mm.
20. Female wasp, in a characteristic pose. From photograph from life by W. Twigg-Smith.



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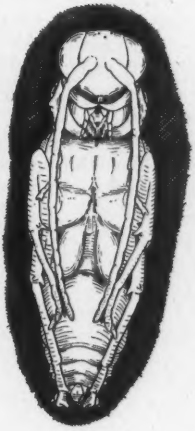

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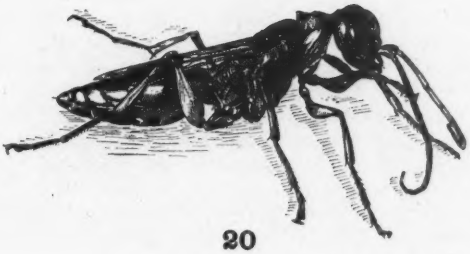

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Ampulex compressa

Soon however *Ampulex* shifted her grip to the middle of the front margin of the pronotum directly behind the head and effectively stung her prey. An old or incautious wasp attacking a vigorous and aggressive roach may be badly bitten in the abdomen, the roach's jaws even breaking a tough sclerite so that the wasp succumbs in a few days. Thus, it was advisable to give the smaller *Ampulex* females a correspondingly small cockroach. In such a case, *Periplaneta australasiae* (Fabr.) was most suitable. Another cockroach readily accepted by *Ampulex* is the large wingless or rather strikingly marked *Neostylopyga rhombifolia* (Stoll). The very common scuttling gray *Nauphoeta cinerea* (Oliv.) drew little or no notice. On one occasion *Ampulex* effectively stung *Diploptera dytiscoides* (Serv.), the beetle-roach, but there the episode ended. Further experiments here would be of interest.

In the attack upon her ill-smelling prey, *Ampulex* avoids touching it more than appears necessary. Thus, one or more of her legs are elevated in air (Fig. 1) while the remainder are employed in bracing herself against the cockroach's struggles. Sometimes *Ampulex* attempts to grasp a lively unstung roach by the base of the antenna. And rarely we find a carton devoid of prey, but nevertheless well stoppered by the wasp! Occasionally we find "wasters" among these wasps. Such a one may sting a cockroach and trim its antennae but proceed no further. Perhaps the wasp's body contained no egg ready for deposition.

The egg of the jewel wasp hatches in about three days, the larva breaking through the blunter end. Excepting for its larger size and a somewhat segmented body, it does not at first differ much from the egg. The larva feeds at or near the spot where it has hatched. It thus lives externally on the coxal plate of its victim for four or five days and during this period overgrows the collapsed egg shell and casts its skin four times, these thin semi-transparent skin membranes accumulating as a flattened pad beneath its body. Thus, during its life as a grub or larva it has used five pairs of mandibles, as illustrated (Figs. 5-11). The first four of these are delicately spine-tipped and are probably employed in puncturing the host's body. The last pair of jaws are large and stout-toothed and it is with these that the larva immediately bites through the cockroach's body to enter it and feed within. This entrance is effected at the junction of the mid-coxa and body; more commonly the upper or mesepimeral, rather than the lower or mesepisternal membrane being chosen (Fig. 3). The larva now feeds ravenously within its weakening host, hollowing out its body even to the base of the legs. The cockroach soon perishes—having provided the wasp during its life as a grub with a continuous supply of fresh meat. The larva, now full fed, white and apparently hairless, commences the formation of a cocoon within the stiffening body of its host. A more loosely woven

outermost envelope of golden brown silk is formed, then follows a fine thin layer of silk which closely envelops the smooth deep brown rather brittle cask that is drawn out funnel or nipple-like at either end. Tough brown leather-like material plugs up the base of each funnel, and this material is superposed by a mat of silk (Figs. 15 and 16). The entire cask is smooth, strong, tight and varnished within and seems impervious to air. The larva may shed its skin to become a pupa within perhaps two weeks, in the warm summer time, or may rest for weeks or even months without pupating, in the cooler or drier season. Such a resting larval stage is common to most or at least to a great many stinging wasps. The pupa is delicate and whitish with a down-bent head. I do not believe that this stage endures more than two or three weeks. Laboratory records here show a minimum of egg plus larva plus cocoon stage of 34 days and a maximum of 140 days. In the laboratory it was found that the insect often died in the resting larval and in the pupal stages.

The pupa gradually acquires the coloration of the adult insect that in due time frees itself of the delicate envelope. It usually issues from the cocoon in the morning when vigorous squeaky buzzes within the dried cockroach announces the wasp's readiness to gain the outer world. Soon one jaw and then the pair may be seen biting through the tough skin and then a scintillating *Ampulex* wasp works its way out bit by bit. It has bitten off a rough cap from the slightly blunter end of the cocoon, which more frequently lies toward the anterior end of the cockroach, and then chewed its way through the latter (Fig. 19).

The wasps mated readily in large jars. Upon discovering an unmated female, the male becoming quite excited faces her, his antennae brought close together forward, his body rapidly shaking from side to side. The female is often annoyed at his attentions and then chases him away. At an opportune moment he succeeds in mating, the process lasting perhaps a minute. But one mating seems necessary; a female once fertilized may successfully parasitize dozens of cockroaches.

Ampulex compressa in its transference from the South Pacific to the Hawaiian Islands north of the equator, immediately conformed to the changed seasons. It is thus most active in all its stages here during our summer time although the wasps did parasitize cockroaches throughout the year in an outdoor laboratory. The warm moist season in New Caledonia is about from November to April, at which time the wasp is active there.

These wasps are long-lived. Several males lived to be two months old and one reached 85 days. It is probable that their life may be a good deal in excess of this figure. Cool weather, rendering the wasps somewhat inactive, seems to increase their longevity.

The following table shows the longevity of females and the number of cockroaches stored by some of these:

Captured in New Caledonia	Died	Days Longevity	No. Cockroaches Stored
October 15, 1940	November 4, 1940	20	Not recorded
" 17, "	December 30, 1940	74	About 65
" 31, "	February 10, 1941	102	About 78
Hatched in Honolulu			
January 6, 1941	May 11, 1941	125	85
" 23, "	" 12, "	109	88
May 12, "	June 12, "	31	20
" 15, "	" 20, "	36	25
" 15, "	Sept. 11, "	119	65
" 25, "	" 9, "	107	55[2]
June 9, "	October 10, "	123	49[2]
" 20, "	" 9, "	111	41[2]
Sept. 15, "	December 16, "	92	33[2]
October 6, "	February 12, 1942	129	46[2]
" 6, "	" 17, "	134	43[2]
" 13, "	March 12, "	150	39[2]
" 24, "	April 1, "	159	57[2]

[2] These wasps were not supplied with a cockroach per day, throughout. Towards the end of their life wasps were often too feeble, stiff and short-winded to successfully cope with a cockroach.

Ampulex compressa was not reared in large numbers, from two to six females each in her large jar being used at one time. This breeding work is now entering its second year. Up to March 31, 1942, two hundred and two mated females and a somewhat smaller number of males have been liberated. Most of these liberations were made in several parts of Honolulu. Two small consignments were released on the Island of Maui and one on Kauai. Already the wasp seems firmly established here, for it has been seen in one locality about the buildings of a chicken farm in Honolulu, for the better part of a year, and is being reported from different parts of the city. In another place where it has been liberated, one to several males may be seen, months afterwards, running up the trunks of certain trees and then taking off for an inspection elsewhere.

The jewel wasp puts up a wonderful exhibition of boldness, skill and strength in the attack on her often huge prey, once to the effect that a French scientist upon witnessing such a battle in our hotel room laboratory in New Caledonia, much impressed, exclaimed: "C'est formidable!" Many have witnessed the wasp's bold exploits in New Caledonia. On our Pan American Airways voyage from Noumea to Honolulu, we stopped for a day and a half at the equatorial atoll of Canton. Here the two *Ampulex* jars were brought out of their travel bags, a large cockroach was given each of the wasps, and airplane passengers, the airplane and the ground crews were treated to an exciting rough and tumble performance. Here

in Honolulu, a large number of the staff of the Hawaiian Sugar Planters' Experiment Station and others have viewed the wasps at work in their outdoor laboratory. In busy downtown Honolulu two of our *Ampulex* wasps formed part of a New Caledonian Exhibit, prepared by Mrs. Williams, in the show window of Pan-American Airways. This exhibition lasted for nearly two weeks and attracted many people. It was found that in addition to working in the day time the wasps would carry on during the night as well in their warm brilliantly illuminated quarters.

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A New Phanerostethus from New Caledonia (Coleoptera: Curculionidae)

BY ELWOOD C. ZIMMERMAN
Bernice P. Bishop Museum

(Presented at the meeting of June 9, 1941)

Among the Rhynchophora collected by Dr. F. X. Williams in New Caledonia for the Hawaiian Sugar Planters' Association in 1940 are two examples of a new species of the cryptorhynchine genus *Phanerostethus* Marshall, 1931. This is the seventh species of the genus to be described, and New Caledonia marks the most western locality at which a species has been discovered.

The known members of the genus, arranged by date of description, are:

1. **Phanerostethus dilophus** Marshall, Insects of Samoa, part 4, fasc. 5, p. 286, fig. 12, 1931. Genotype.
   Samoa: Upolu.
2. **Phanerostethus ingens** Zimmerman, Bishop Mus. Occasional Papers, *12*(23): 43, figs. 2, *f*; 3, *b*, 1936.
   Society Islands: Raiatea.

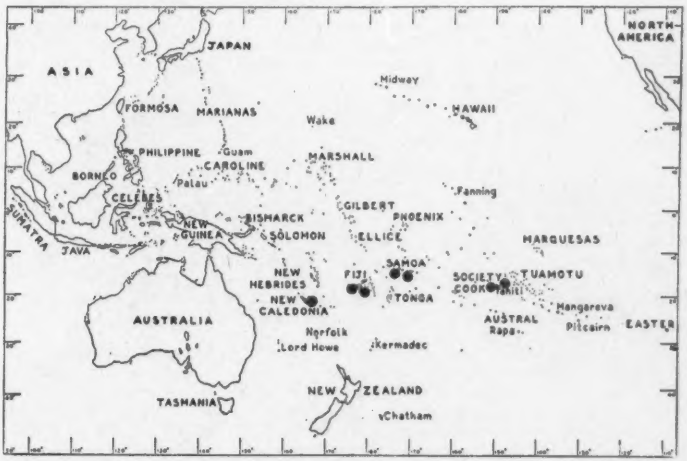

Fig. 1.—Map showing the distribution of the described species of *Phanerostethus*.

3. **Phanerostethus pallidiceps** Zimmerman, Bishop Mus. Occasional Papers, *12*(23) : 44, fig. 3, *c*, 1936.
   Society Islands: Tahiti.

4. **Phanerostethus vitiensis** Zimmerman, Bishop Mus. Occasional Papers, *14*(17) : 318, fig. 1, *a*, *b*, 1939.
   Fiji: Viti Levu, Taveuni, Ovalau, Matuka, Moala, Tuvutha.

5. **Phanerostethus fasciculatus** Zimmerman, Bishop Mus. Occasional Papers, *14*(17) : 319, fig. 1, *c*, *d*, 1939.
   Fiji: Described from Tuvutha, but now known to be widespread in Fiji.

6. **Phanerostethus maculosus** Zimmerman, Bishop Mus. Occasional Papers, *16*(7) : 169, fig. 1, *a*, *e*, 1941.
   Samoa: Tutuila.

7. **Phanerostethus niger** Zimmerman, new species.
   New Caledonia.

The known geographical distribution of the genus is indicated on the accompanying map (fig. 1).

Phanerostethus niger, new species (fig. 2).

Female. Derm reddish brown, piceous to black; scaling dense and appressed, predominantly black above; scales on the base of the rostrum mostly white, those on the head almost all black; pronotum entirely with black scales except for a small, elongate, basal patch of brownish yellow scales in front of the scutellum and a few pale scales near the outer corners of the basal margin; elytra with mottled darker and paler black scaling, the darker patches velvety black, the paler ground areas more iridescent, with a conspicuous patch of pure white scales on intervals 7 and 8 above the suture between the first and second ventrites, this followed by a larger conspicuous patch of brownish yellow scales across intervals 4, 5 and 6 in echelon, and with small, irregular, scattered patches of similarly colored scales on the declivity; legs with the femora with black scaling and with the scaling on their basal fourths or thirds white, the remainder flecked with white squamiform setae; tibiae black in the basal half, white in the distal half or more, the setae among the black scales black, among the white scales white; undersurface with predominantly white or grey scales.

Head with the puncturation hidden by the dense scaling which is flat and appressed and not arranged like honey-comb; the interocular area depressed, with scattered, slanting, round-tipped, lanceolate setae, those along the inner margins of the eyes largest. *Rostrum* with the squamae confined to the sides behind the antennae; derm shiny, finely punctate; the extreme distal breadth equal to the breadth of the interocular area and that two-tenths broader than the breadth at the antennae. *Antennae* with the scape distinctly clavate, as long as the first four funicular segments; funicular segment 1 stout, twice as long as broad, about as long as 2 plus 3, almost twice as broad as 2; segment 2 not quite as long as 3 plus half of 4; segments 3 and 4 subequal in length; segments 5 to 7 successively broader; club about

as long as the preceding five segments. *Prothorax* slightly transverse (42 to 38 on the holotype), broadest at about the basal third, arcuate on the sides to the broad subapical constriction at the apical third; the constriction continued broadly, and shallowly across the dorsum and not conspicuously impressed; base slanting slightly upward above the base of the elytra, the highest point reached within the basal fourth and there only slightly higher than the highest elevation of the elytra; puncturation entirely concealed by the dense squamae; the scales shallowly concave and in some lights giving a slight honeycomb-like appearance, especially on the sides; with numerous, stout, erect, mostly black, conspicuous, spatulate setae scattered over all. *Elytra* sinuous at the base, five-sevenths as broad as long, twice as long as the prothorax, measured from the side, arcuate on the sides; without subapical calli; striae narrow but well defined, their punctures small, the tenth striae extending to above the hind coxae, striae 7 and 8 not reaching the base; intervals plain, slightly convex, the first intervals distinctly narrowed in the basal third and only one-half as broad as a second interval in the basal fourth, each interval with a row of long, erect, narrowly spatulate or peg-like conspicuous setae. *Legs* with numerous squamiform or peg-like setae, those on the tibiae more erect. *Sternum* with the pectoral canal squamose in the prosternal and mesosternal parts but bare between the fore coxae; mesosternal receptacle with well-developed, high side walls, the receptacle terminating just behind the middle of the mesocoxae in the female; metasternum densely punctate, squamose, flattened transversely. *Venter* densely squamose, the scales appressed; the squamiform setae scattered on

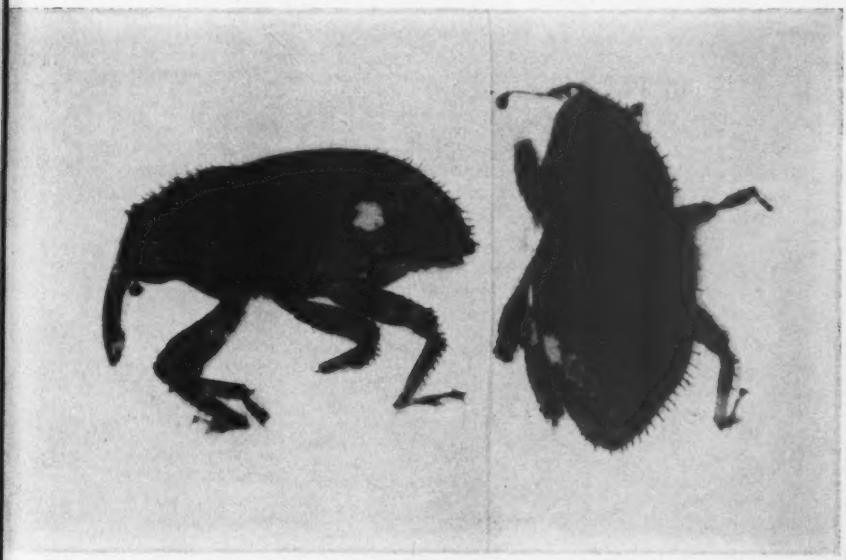

Fig. 2.—*Phanerostethus niger*, new species, holotype female. Photographs by W. Twigg-Smith.

the first, second and fifth ventrites, in a single row across the third and fourth ventrites; first ventrite convex, as long as ventrites 2, 3, and 4 combined. Length: 2.7 mm.; breadth: 1.25 mm.

New Caledonia. Holotype female collected from a broad leaved *Acacia* near the sea shore at Noumea, August 19, and one female paratype collected from *Acacia laurifolia,* at Noumea, September 6, 1940, by F. X. Williams.

The only other species of the six previously described species that has predominantly black scaling is *Phanerostethus vitiensis* Zimmerman. That species is, however, obviously distinct from this one because of numerous structural characters. The new species has the longitudinal dorsal contours of the pronotum and elytra less discontinuous than any of the other described species.

A series of specimens may show variation in the arrangement and extent of the maculae on the elytra. On the two specimens before me, these maculae are distinct to the unaided eyes. The paratype is not as clean and fresh as is the holotype.

Dr. Williams has kindly given me permission to store the holotype in the type collection of Bishop Museum.

A New Scydmaenid from Hawaii (Coleoptera)

BY ELWOOD C. ZIMMERMAN
Bernice P. Bishop Museum

(Presented at the meeting of June 9, 1941)

The first data concerning the family Scydmaenidae in the Hawaiian islands were recorded by Van Zwaluwenburg, Proc. Haw. Ent. Soc. *8*(1) : 24, 1932. The family is not known to be represented in the endemic fauna of Hawaii. The species recorded by Van Zwaluwenburg, although we consider it adventitious, has apparently never been described. In 1932, some specimens collected by Van Zwaluwenburg were sent to the United States National Museum for identification; these specimens were subsequently forwarded to Dr. Ctibor Blattny, Prague, Czechoslovakia. Dr. Blattny apparently intended to describe the species as new, because specimens were returned under the manuscript name *"Cephennodes hawaiicus* Blattny". However, we have been unable to find any record of the description of the species or a reference to such a description.

It is desirable to have a name for the Hawaiian species, and Mr. Van Zwaluwenburg has asked me to draw up a description. I have done this with some diffidence, however, because I am not familiar with the taxonomy of the family. Mr. L. L. Buchanan has written to Mr. Van Zwaluwenburg, "If you wish to publish on this species,

I suppose it will be necessary first to prepare and publish a description disregarding Dr. Blattny's apparent intention to do this". In view of the present world conflict and the opinion of entomologists here and at the National Museum, I present the description of the scydmaenid which has remained in our collections without a proper name.

I have dedicated the species to Mr. Van Zwaluwenburg, because he is the one responsible for the discovery of this interesting insect and for continued effort in obtaining a name for it.

Because of the finely margined lateral edges of the prothorax, I follow Dr. Blattny in placing the new species in *Cephennodes* rather than in *Cephennium*. *Cephennodes* has been considered by some authors to be a subgenus of *Cephennium*.

Cephennodes zwaluwenburgi, new species (figs. 1, 2).

"Cephennium sp.", Van Zwaluwenburg, Proc. Haw. Ent. Soc. *8*(1) : 24, 1932.

Cephennodes hawaiicus Blattny, ms. name, in litt., not published with a description; note by Van Zwaluwenburg in Proc. Haw. Ent. Soc. *8*(2) : 229, 1933.

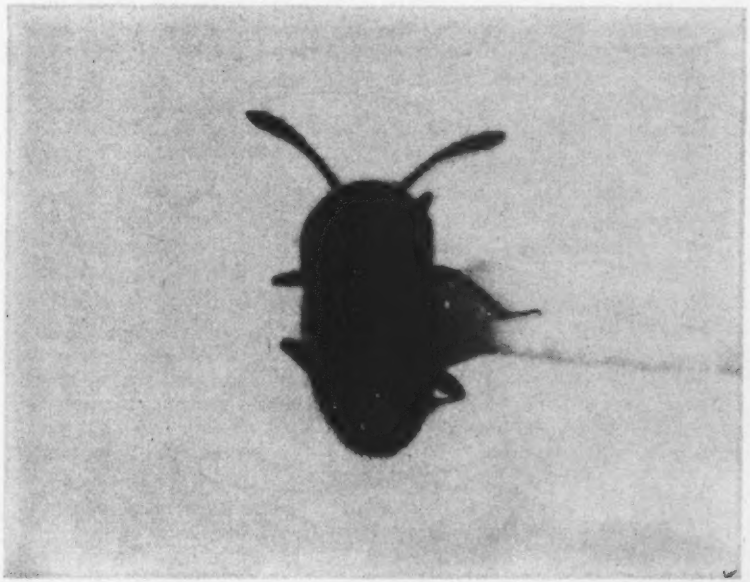

Fig. 1. *Cephennodes zwaluwenburgi,* new species. Photograph by Twigg-Smith. × 50

Derm shiny reddish brown, appendages, especially the legs, usually more yellowish brown, vestiture dense, long, conspicuous, golden in color.

Head minutely, inconspicuously punctate; the interscrobal suture separating the clypeus from the front feeble and inconspicuous or obsolete; the shortest distance across the front between the inner margins of the antennal scrobes one-half that between the inner margins of the eyes; the greatest distance between the outer edges of the eyes one-fourth greater than the median length of the head from a line drawn between the dorsal edges of the eyes and the apex of the closed mandibles; eyes one-third higher than long, ovate, hirsute. *Antennae* slightly longer than the greatest pronotal breadth, rather densely hirsute, the hairs on the first nine segments longer than the segments; segment 1 truncate-conical; segment 2 about as long as 3 plus 4, almost twice as long as broad, cylindrical; segments 3-6 inclusive each about as broad as long, subcylindrical; 7 about one-third longer than 6, twice as long as broad, slightly longer than 8; 8 about one-third broader than long; club distinctly three segmented; segment 9 transverse, three-fourths as long as 10; 10 one-third broader than long; 11 twice as long as 10, slightly longer than broad, pointed, the sides arcuate (the segments of the club measured on their broad sides). *Prothorax* shaped as illustrated, transverse, (breadth 32, length 24, measured from above), the median longitudinal dorsal contour evenly convex; posterior margin bisinuate, postero-lateral corners acute; minutely punctate, the punctures bearing long, curved, posteriorly directed hairs; the fovea near each hind angle conspicuous. *Elytra* about four-fifths as broad as long, slightly more than twice as long as the pronotum as measured from the side; sculpture and vestiture similar to that of the pronotum, the hairs long, curved, inclined; longitudinal dorsal contour rather evenly arcuate, discontinuous with that of the pronotum; each elytron with a large, conspicuous impression at the base between about the middle and the suture

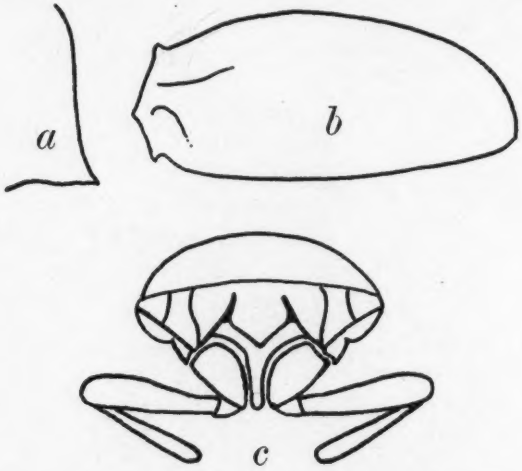

Fig. 2. Diagrams of details of *Cephennodes zwaluwenburgi*, new species. *a*, posterior corner of pronotum; *b*, elytron; *c*, view of prothorax removed from body, caudal aspect. Diagrams from camera lucida outlines from balsam mounts.

and which contains a small fascicle near the basal margin. *Wings* fully developed. *Legs* slender, hind femora about as long as the hind tibiae; hind tibiae slenderly clavate, nine times as long as the greatest breadth, about one-third longer than the hind tarsi, without any distinct apical spurs; mid and hind tarsi with the segments more elongate than those of the fore tarsi, the first segment of a hind tarsus about one-third longer than the greatest breadth of a hind tibia. *Sternum* with the intercoxal process of the prosternum produced into a thin lamella that extends fully to the lowest level of the coxae; the fore coxae with their outer sides forming a straight line and in line with the pro-thoracic pleurae, their lengths four-tenths longer than their breadths, one-half as long as a fore femora and trochanter combined, the prosternal area before and behind the coxae very narrow; intercoxal process of the mesosternum somewhat similarly developed as that of the prosternum, but at least twice as broad; metasternum, measured along the side, two-thirds as long as broad, broadly, deeply and conspicuously impressed in the basal third to the mesocoxae, the punctures small but distinct and bearing long slanting hairs similar to those on the elytra, the intercoxal process as broad at its apex as the length of the first ventrite, evidently truncate, but appearing emarginate. *Venter* with the long hairs slanting away from the derm at an angle of about 45 degrees, the first five ventrites subequal in length along the median line; the fifth segment about one-fourth shorter than the first; ventrite six as long as five plus about one-half of four. Length: 0.8 mm.; breadth, 0.45 mm.

Hawaii: Island of Oahu. Holotype collected by me at light in Makiki, Honolulu, May 4, 1937, in Bishop Museum; two paratypes collected by flotation from soil from Mt. Tantalus, August 1930, by Van Zwaluwenburg [one of the specimens bears a label "*Cephennium* sp. not in B(ritish) M(useum)" and was determined by G. E. Bryant]; one dissected specimen with its head missing and mounted in balsam on a slide from sugar cane soil from Honolulu, 1931, collected by Van Zwaluwenburg, and an additional specimen with the same data from the United States National Museum. The latter is an immature, pale, straw colored example. As a designated paratype it will be returned to the National Museum. It bears the labels "*Cephennodes hawaiicus* m. Blattny det.", "2 specimens sent to Blattny for determination March 1932" and "Returned by Blattny, paratype (?)".

This minute addition to the Hawaiian coleopterous fauna can be easily recognized. In appearance it resembles a miniature member of the Eucnemidae or Elateridae. It appears to me that the species is almost certainly an introduced form. It is not possible for me to say whence it came, however, the Scydmaenidae of Oceania are unknown—probably not more than a half dozen species have been described from that area.

A List of Parasitic Hymenoptera Collected by F. X. Williams in New Caledonia

BY D. T. FULLAWAY
Board of Agriculture and Forestry.

(Presented at the meeting of December 22, 1941)

For some years the author has paid particular attention to the Parasitic Hymenoptera collected on islands located in the Pacific Ocean, mainly through the kindness of the entomologists at the Bishop Museum and the H.S.P.A. Experiment Station in allowing me to study their extensive collections of these insects. The collection made by Dr. F. X. Williams during an extended tour in New Caledonia in 1940 is a very interesting one from the viewpoint of geographical distribution, and I believe the publication of a list of the species, although many of them cannot at present be accurately identified, would be of some use to future workers in this field.

EVANIIDAE

Evania appendigaster (Linn.). Noumea, July 4, 1940, 1 example.

Evania sericea Cam. Oua Tom, Sept. 19, 1940, 1 example.

Evania laevipetiolata Turner. Thi River Valley, Nov. 6, 1940, and Noumea, 2 examples.

Gasteruption sp. Thi River Valley, Nov. 8, 1940, 5 examples.

ICHNEUMONIDAE

Ichneumonini

Ichneumon promissorius Erich. Col. de la Pirogue, Sept. 1940, 1 ex.; Noumea, Sept.-Oct. 1940, 3 ex.; St. Louis, Oct. 1940, 1 ex.; Hienghene, Oct. 5, 1940, 2 ex.; La Foa, Sept. 1940, 1 ex.; Thi River Valley, Nov. 6, 1940, 1 example.

Amblyteles sp. Noumea, Oct. 17, 1940, 1 example.

Acolobus sp. Yahoue, Sept. 1940, 1 example.

Cryptini

Mesostenus sp. Thi River Valley, Nov. 1-8, 1940, 2 examples; Yahoue Valley, Aug. 29, 1940, 1 example.

Buodias unicolor Turner. Noumea, Sept. 23, 1940, 1 example.

Cosmiocryptus sp. St. Louis, Aug. 17, 1940, 1 male.

Spilocryptus sp. St. Louis, Oct. 14, 1940, 1 example.

Cryptus sp. Mt. Dzumao, Sept. 4, 1940, ex *Tristania* ? flowers, 1 example.

Paurophatnus sp. Oua Tom, Sept. 19, 1940, 1 example.

Pimplini

Phytodietus austrocaledonicus Turner. Mt. Mou, Aug. 21, 1940, 3900 ft., 1 female.

Coleocentrus sp. Yahoue Valley, Sept. 11, 1940, 1 example; Nepoui Valley, July 1940, 1 example.

Certonotus n. sp. Hills behind Noumea, Oct. 16, 1940, 1 example.

Eugalta sp. Thi River Valley, Nov. 8, 1940, 1 female.

Lissopimpla pacifica Morley. Nepoui Valley, July 1940, 3 examples; St. Louis, Aug. 1940, 2 examples.

Theronia simillima Turner. Thi River Valley, Nov. 6-8, 1940, 3 females; Noumea, July-Sept., 5 females, piercing *Melaleuca* bark to get at noctuid pupa.

Echthromorpha quodi Vachal (*equisita* Morley). Thi River Valley, Nov. 6, 1940, 2 females; possibly 1 male from Noumea, Sept. 9, 1940.

Echthromorpha platymischa Vachal (*inermis* Morley). St. Louis, Oct. 14, 1940, 2 females, 4 males; Prony Bay, Oct. 22, 1940, ex *Nepenthes* tube, 1 female; Noumea, July-Nov. 1940, 3 females, 12 males; Nepoui Valley, July 1940, 5 males; Thi River Valley, Nov. 6, 1940, 3 females; Yahoue Valley, Aug. 29, 1940, 1 male; St. Louis, Aug. 17, 1940, 1 male.

Echthromorpha ceramocare Vachal (*bitecta* Morley). Nepoui Valley, July 1940, 4 males; Thi River Valley, Nov. 1-6, 1940, 6 females.

Echthromorpha semperi Krieger. Nepoui Valley, July 1940, 1 male.

Tryphonini

Scolobates sp. Noumea, Sept. 2, 1940, Mt. Mou, Aug. 21, 1940, 2 examples.

Diplazon (Bassus) laetatorius (Fabr.). Noumea, Oct. 30, 1940; Isle of Pines, Oct. 24, 1940, 2 examples.

Ophionini

Campoplex karkil Cheesman. Noumea, Sept. 17-26, 1940, 2 examples; Thi River Valley, Nov. 6-8, 1940, 2 examples; Hills behind Noumea, Oct. 19, 1940, 1 example; Nepoui Valley, July 1940, 1 example.

Enicospilus coarctatus Brullé. Thi River Valley, Nov. 1, 1940, 1 example.

Enicospilus obliquus Morley (*bakeri* Cheesman?). St. Louis, Aug. 17, 1940, 1 example.

Enicospilus nigrinervis Cam. (*rhoedae* Cheesman?). Thi River Valley, Nov. 1, 1940, 1 example.

Enicospilus gardei Morley. Thi River Valley, Nov. 1, 1940, 1 example.

Enicospilus trinotatus Morley. Noumea, Sept. 13, 1940, 1 example; Thi River Valley, Nov. 6, 1940, 1 example.

Zachresta lua Cheesman. Noumea, July-Aug. 1940, 1 example.

Angitia sp. Mt. Mou, Aug. 21, 1940, 1 example.

Zaporus sp. Noumea, Aug.-Nov. 1940, 5 examples.

Mesochorus sp. La Foa, Sept. 1940, 1 example.

Hymenobosmina iavilai Cheesman. Nouville, Aug. 9, 1940, 1 example.

Paniscus antipodum Vachal. St. Louis, July-Oct. 1940, 13 examples; Noumea, Aug.-Sept. 1940, 8 examples; Isle of Pines, Oct. 29, 1940, 1 example; Oua Tom, Sept. 19-20, 1940, 3 examples; Thi River Valley, Nov. 8, 1940, 1 example; Nepoui Valley, July 1940, 4 examples.

Ophion sp. Hills behind Noumea, July 17, 1940, and Noumea, Aug. 1940, 2 examples.

Agrypon omabensis Cheesman. Thi River Valley, Nov. 8, 1940, 1 example.

ALYSIIDAE

Alysia sp. Noumea, Sept. 9, 1940, swept off turnip plants, 3 examples.

STEPHANIDAE

Stephanus sp. Prony Bay, Oct. 22, 1940, 2 examples.

BRACONIDAE

Bracon sp. (reddish brown). Oua Tom, Sept. 20, 1940; hills behind Noumea, Aug. 18, 1940, beaten ex forest tree, 2 examples.

Ipobracon novocaledonicus Szepl. Yahoue Valley, Aug. 14 and 29, 1940, 2 examples; Thi River Valley, Oct. 24 and Nov. 1-8, 1940, 6 examples.

Iphiaulax sp. Oua Tom, Sept. 19, 1940, 1 example.

Cyanopterus rutilans Turner. Thi River Valley, Nov. 1-8, 1940, 4 examples; Isle of Pines, Oct. 24, 1940, 1 example; Nepoui Valley, July 1940, 1 example.

Bracon sp. Mt. Dzumao, Sept. 4, 1940, ex *Tristania* ? flowers, 1 example and beaten off forest tree.

Spathius sp. Thi River Valley, Nov. 8, 1940, 1 example.

Ontsira sp. Noumea, Aug. 19, 1940, 1 example.

Ischiogonus sp. Noumea, Sept. 6, 1940, beaten ex *Vitex negundo* trees.

Chelonus sp. Yahoue Valley, Aug. 29, 1940, ex large leaves and rough scaly stem of forest taro, 2 examples; Nakety, Oct. 9, 1940, 1 example.

Phanerotoma sp. Noumea, July-Aug. 1940, 4 examples.

Apanteles sp. Isle of Pines, Oct. 1940, 1 example; Houailou River, Oct. 7, 1940, 1 example.

Orgiloneura sp. Hienghene, Oct. 5, 1940, 1 example (river coast).

Aphidius sp. Noumea, Sept. 9, 1940, swept off turnip plants.

Zele sp. Noumea, 1940, 1 example.

Apanteles sp. Noumea, July-Nov. 1940, ex-pigeon pea leaf-roller material, 1 example, and swept off grass and yellow *Ipomoea* flowers, 1 example; Mt. Dzumao, Sept. 4, 1940, ex *Tristania* ? flowers, 1 example.

CHALCIDIDAE

Chalcis sp. Noumea, July-Nov. 1940, 8 examples; Hienghene estuary river-shore, beaten ex trees and shrubs, Oct. 5, 1940, 1 example; Dzumao, 1940, 1 example.

Chalcis sp. La Foa, Sept. 1940, 1 example; Noumea, July-Aug. 1940, 2 examples; St. Louis, Oct. 29, 1940, 2 examples; Isle of Pines, Oct. 1940, 1 example; Hills behind Noumea, July-Aug. 1940, 1 example.

Leucospis antiqua Walk. Noumea, Oct.-Nov. 1940, 6 examples; Hills behind Noumea, Oct. 19, 1940, 1 example; Prony Bay, Oct. 22, 1940, 1 example; Nepoui Valley, July 1940, 1 example; Thi River Valley, Nov. 6, 1940, 1 example.

Dirhinus sp. Noumea, Aug. 26, Nov. 5, 1940, ex *Acacia laurifolia,* beaten off live and dead branches, 2 examples.

Miscogasterid. Nepoui, Aug. 1940, on sugar cane, 1 example; Hills behind Noumea, July 17, 1940, 1 example.

Podagrion sp. Noumea, Aug.-Sept. 1940, 2 examples, ex Mantid egg-case.

Eurytomid. Near Mt. Dzumao, Sept. 1940, sweeping, 1 example; Thi River Valley, Nov. 8, 1940, 1 example.

Eupelmid. Noumea, Aug.-Nov. 1940, 11 examples; Hills behind Noumea, Aug. 1940, 12 examples; on *Melaleuca* ("Niaouli") bark; Noumea, July-Oct. 1940, 4 examples; Hills behind Noumea, Aug. 1940, 3 examples; Nepoui Valley, July 1940, 1 example, on *Melaleuca* ("Niaouli") bark; Noumea, Oct. 1940, 1 example; Nouville, Aug. 8, 1940, 2 examples.

Eupelmid (yellow). Yahoue Valley, Aug. 29, 1940, large leaves and rough scaly bark of forest taro, 1 example.

Encyrtid. Nouville, Aug. 10, 1940, ex green *Hibiscus tiliaceus* psyllid (*Mesohomotoma hibisci* [Froggatt]).

Melittobia hawaiiensis Perkins. Near Noumea, Sept. 1940, ex *Eumenes* pupae, 14 examples (on 3 tags).

Eulophid. Noumea, Nov. 1940, 2 examples and near Nondhoue, Sept. 9, 1940, ex *Grevillea* and pigeon pea lepidopterous leafminer material, 2 examples; Hills behind Noumea, July-Aug. 1940, 2 examples; Noumea, Sept. 1940, ex dipterous turnip leafminer.

PROCTOTRUPIDAE

Sclerodermus sp. Hills behind Noumea, Aug. 1940, Niaouli (*Melaleuca*) trees, 2 examples.

Diapriid. Nepoui, Aug. 1940, sugar cane, 1 example.

Goniozus sp. Noumea, Aug. 13, 1940, broad-leaf *Acacia,* 1 example.

Telenomus sp. Hills behind Noumea, Aug. 15, 1940, beaten ex dwarf *Casuarina,* 1 example.

CYNIPIDAE

Cynipid. Noumea, Aug.-Sept. 1940, ex dipterous turnip leafminer *Liriomyza pusilla,* 8 examples (on 2 tags).

Records of Immigrant Insects for the Year 1941

BY THE EDITOR

In this issue of the Proceedings, the following immigrant species are recorded for Hawaii. Those marked with an asterisk were observed for the first time at the date mentioned in 1941. The others were previously observed or known but not yet identified, or wrongly identified. For details of records, etc., refer in the text to the pages as given.

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Insects of the Garden Bean in Hawaii*

BY F. G. HOLDAWAY† AND WILLIAM C. LOOK‡

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INTRODUCTION

When, in 1937, an Entomology Department was reestablished in the Hawaii Agricultural Experiment Station, it was found that the crops of diversified agriculture in which the Station and the community were interested were different from those which came within the field of work of the Entomology Department which had existed in the Station over 20 years before. Moreover, it was also found that many of the insects which occurred on these crops had been recorded in Hawaii only a comparatively few years before and little was known of them from the standpoints of abundance and crop injury. In order to secure perspective regarding the crop insects, surveys have been made of those of the more important crops.

This paper is the first of a series in which will be recorded a census of the insects known to date on crops, other than sugarcane and pineapple, in Hawaii. Where possible, information will be given on relative importance, distribution and seasonal incidence. The insects will be discussed under the headings of major pests, sub-major pests, minor pests, beneficial insects, and incidental insects. It will not be surprising if, as additional information is secured, or as crop abundance, or relative crop abundance changes, some modification of the grouping given here will be necessary. Already one change, that of whiteflies from a minor pest to a

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major pest, has been necessitated by records secured since the main observations on which this paper is baesd, were made. Moreover it cannot be considered that the census is complete. It is merely as complete as it has been possible to make it in the time allotted for securing information sufficient for prosecuting work on the applied entomology of the respective crops. Records of additional insects on the crops will undoubtedly be secured.

The major insects will be classified on an ecological basis in a manner somewhat similar to that so well developed by Graham [1*] for Forest Insects. Modifications of the system developed by Graham have been necessary to meet the special needs of truck and field crops. A general outline of the system which will be used in this series of papers follows.

A. Foliage insects
   (i) Foliage-consuming insects
   (ii) Leaf-mining insects
   (iii) Sap-sucking insects (including mites)
B. Insects attacking the meristem of terminal parts
C. Stem insects
   (i) Sap-sucking insects (including mites)
   (ii) Stem-boring insects
D. Insects of the reproductive organs
   (i) Flower insects or insects of the inflorescence
   (ii) Fruit insects
   (iii) Seed insects
E. Root and tuber insects
F. Soil insects

The common names used are those adopted recently by the Hawaiian Entomological Society following a report submitted by a committee appointed by the Society to bring up to date the list of names for common and economically important insects in Hawaii.

* * *

The garden or green string bean, *Phaseolus vulgaris*, with an annual production of more than one and one half million pounds, is one of the most important vegetable crops grown in the Territory. For the fiscal year 1937-38 [3] the crop was valued at $121,481. In 1940 [4] the Territory was 100 per cent self-sufficient in the production of green beans. The main production occurs on the island of Oahu, where most of the observations on which the present article is based have been made. "Pole" beans have been the most popular type grown, and so most of the observations have been made on pole varieties.

The most important pests are a foliage-feeding beetle, a leaf-

* Reference is made by number to Literature Cited.

hopper, a plant-bug, an aphid, mites, a whitefly, and a pod-boring caterpillar. Eight major pests, three sub-major pests, twenty-three minor pests, and twenty-two species of beneficial insects are recorded here. Thirty-two additional species are recorded as incidental. The incidence of the respective pests varies with season and place; never are they all present on a crop at the same time. The differences in climate associated with elevation and windward and lee locations are comparatively marked in short distances. Thus it is not surprising to find the insect picture differing markedly in localities a few miles, or even a fraction of a mile, apart. Most of the observations recorded here were made during the years 1938-40 inclusive.

Major Pests

Foliage Insects

Foliage-consuming insects

Adoretus sinicus Burmeister, Chinese rose beetle—Coleoptera, Scarabaeidae

This beetle was introduced from the Orient, as an immigrant, some time prior to 1896 [13]. At night, the adults devour the leaves, and may also attack the buds. During the day they may be found in the soil, or hidden among dried leaves, beneath the plants being attacked. When the beetle is abundant, bean plants may be skeletonized. No quantitative data are available on the geographic and seasonal abundance of the beetle. General observations, however, suggest that it has been particularly abundant at Waipahu, Heeia and Honolulu. Sections of Honolulu at a greater elevation and having a higher rainfall experience little injury at times when sections at a lower elevation with less rainfall are experiencing severe injury. Though the beetle is present at Lualualei, Waialua and Kaaawa, the damage at these places is relatively negligible. While our data are perhaps still too scanty for generalization, our observations suggest that attack is least in the very dry and the relatively moist sections, and is more marked in regions of intermediate rainfall. In general, it appears that in those localities in which the insect occurs, attack on beans is most severe during the summer months, but it may be quite serious during the winter months in periods of prolonged dry weather.* Chinese cabbage, corn, taro, grape, eggplant, okra and roses are other economic plants which are commonly attacked severely.

* In Hawaii the mean monthly temperature of the hottest month differs by only a few degrees from the mean monthly temperature of the coldest month. For Honolulu the difference is 7.6° F. The average for nineteen stations on Oahu is 7.4° F; the difference for Hawaii is 5.2° F. and that for Kauai 7.9° F. It seems probable, therefore, that the differences in moisture conditions between summer and winter which are commonly quite marked are more important factors determining seasonal activity than are differences in temperature.

Sap-sucking Insects

Empoasca solana DeLong, Bean leafhopper—Hemiptera, Jassidae

This small, green, leafhopper was first found on amaranth in 1918 [15]. Today it is one of the most serious enemies of the garden bean. The nymph may be recognized by its pale yellowish-green color and by the sidewise movements it makes. Adults and nymphs feed on the undersurface of the leaves, sucking the sap and producing "hopperburn." *Empoasca solana* is rather widespread on Oahu. It is especially abundant on beans at Lualualei where as many as 28 hoppers per leaflet have been recorded. It is also comparatively abundant on bush beans at Waialua. At Waipahu as many as 11 hoppers per leaflet have been recorded. Though fairly abundant on castor beans at Kahuku, this insect is found only occasionally on beans growing in this locality. It is present in small numbers at Kaneohe and Kaaawa. Blackeye cowpea, beet, Swiss chard, peanut, lima bean, lettuce, celtuce, Irish potato, summer squash, celery and eggplant are other hosts. Blackeye cowpea is particularly susceptible. On this crop the insect breeds rapidly and causes serious puckering, distortion and yellowing of the leaves.

Pycnoderes quadrimaculatus Guérin, Bean Capsid—Hemiptera, Capsidae

This mottled, black, grey and white capsid was first found in Hawaii, feeding on purslane, on December 11, 1929 [8]. It was recorded on squash on May 30, 1932 [9]. Both of these records were for Oahu. It probably arrived here from California where it is very injurious to cucurbits. It became increasingly abundant in 1933 and in 1934 was recorded on Kauai [10]. It is particularly abundant on beans in hot, dry sections, such as Lualualei, where as many as 45 individuals per leaflet have been recorded on plants two months old. The black excrement of the bugs is commonly seen on the undersurface of leaves which carry a large number of bugs and gives a characteristic appearance to heavy infestations. Leaf damage by this bug at Waialua is, to a certain extent, comparable to that at Lualualei. At the Waipahu school gardens and Kaaawa, the number is very small, seldom exceeding three to four bugs per row of 50 feet. The plants are injured by the depletion of sap due to the constant sucking of the bugs, which are commonly found on the undersurface of the leaves. Injury shows as a light stippling on the upper surface of the leaves and is not unlike the injury caused by red spider. Cucurbits, white mustard cabbage, and sweetpotato are also severely attacked by this bug in the hot, dry regions in which it is abundant. Okra is also a host.

A parasitic fungus *Entomophthora sphaerosperma* Fresenius* has been recorded attacking individuals on pumpkins, white cabbage, dishcloth gourd, and wild spiny cucumber at Lualualei [11] but has not yet been observed on bugs feeding on bean plants.

Aphis medicaginis Koch, Cowpea aphid—Homoptera, Aphididae

The cowpea aphid, which has been in Hawaii for more than 30 years, was probably introduced from California [13]. The adults are shiny black while the nymphs are dull grayish in color. Large colonies often infest the leaves, stems, and pods of plants of all ages and cause the plants to wither and die. This aphid is an important economic pest of a number of legumes, and is at times abundant also on *Portulaca oleracea* and other weeds from which it often migrates to young bean plants. Today its presence will be noticed on beans, at some time of the year, in almost every region of Oahu. It is particularly injurious to beans of the cowpea group. It is seldom abundant on non-legume crops but has been recorded also on asparagus and tomato.

Trialeurodes vaporariorum (Westwood),† Greenhouse whitefly —Homoptera, Aleyrodidae

At the time most of the observations recorded here were made, whitefly was regarded as a minor pest. Since the winter of 1940-41, however, this insect has been so numerous in the hot, dry sections of Waianae, Lualualei, Nanakuli and Maili that it must henceforth be regarded as a major pest. During the period January to June 1942, infestations have been heavy in these sections. In March and April, infestations were so heavy that serious crop losses occurred until a means of combating the insect was secured. On heavily infested leaves there is not a square centimeter free from eggs, nymphs or adults. The foliage becomes wet with the sticky secretions of the whiteflies and finally becomes dry and brown, assuming a scorched appearance.

Tetranychus sp.? near **T. bimaculatus** Harv.‡ "Red spider" mite—Acarina, Tetranychidae

Hemitarsonemus latus (Banks),§ White or "Broad mite"—Acarina, Tarsonemidae

There are at least two species of mites on garden beans—the "red spider" mite **Tetranychus** sp., possibly a new species, and a "white" mite *Hemitarsonemus latus*. These two mites are among the most injurious pests on the foliage of the garden bean. Infes-

* Identification by Prof. Wm. H. Weston, Harvard University.
† Provisional identification.
‡ Identification by E. A. McGregor.
§ Identification by H. E. Ewing.

tations of both species are especially high during the hot, dry seasons and in the arid sections of Oahu. They produce different symptoms on the leaves.

The "red spider" is commonly found on the lower surface of the leaves associated with a web of fine silky thread. The older leaves are often attacked and stippled with whitish spots which are evident on the upper surface. Heavily infested leaves usually turn yellow and drop off.

Unlike the "red spider" which is larger and orange to orange red in color, the "white" mite is pearly white and can be seen only with difficulty with the naked eye. It generally attacks the young growing leaves. Infested leaves are distorted, crinkled, and underdeveloped; the undersurface commonly has a rusty color. Growth of the plant ceases when the infestation is great and uncontrolled. The red spider undoubtedly has a large number of hosts, but until identity of the species on bean is established beyond doubt little can be said about other hosts. In Hawaii *Hemitarsonemus latus* has been recorded on papaya, [7] Swiss chard and sweetpotato. Injury resembling that of *Hemitarsonemus latus* has been observed on pepper, beet, tomato, Irish potato, eggplant, watercress and Jimson weed.

Stem Insects

Sap-sucking insects (including mites)

Aphis medicaginis which feeds on the undersurface of the foliage infests also the stems—and at times the pods, too. The mite *Hemitarsonemus latus* which occurs on the undersurface of the foliage is found also on the young stems.

Stem-boring insects

The pod borer, *Maruca testulalis,* discussed at greater length under the heading of pod insects does some injury by boring into the stems.

Pod-attacking Insects

Maruca testulalis (Geyer), Bean pod borer—Lepidoptera, Pyralidae

The bean pod borer, an insect which occurs in the East Indies and other tropical and sub-tropical places, first came to notice on green peas and later on lima beans in 1922 [13]. Unlike the bean butterfly, which is commonly seen flying about the bean fields during day, the adults of the pod borer are seldom seen. The moths which are white and brown are mainly nocturnal; they are commonly found hidden among the lower leaves of the bean plants but may be seen on the wing in the daytime during dull weather. The larvae are cream-colored with brown spots. Young larvae may feed on any of the floral parts and on the foliage but are most commonly

found boring in the pods. Pods damaged early may be shed or may become deformed and unmarketable. Larger pods, when attacked, are rendered unfit for market by the unsightly holes and the mass of wet excrement. Up to the present, severe damage has been observed only at Mokapu, Waipahu, and Waialua. However, this pod borer must be considered as one of the most destructive insects of beans in Hawaii. Much of the damage attributed to bean butterfly in the past should undoubtedly be credited to *Maruca testulalis* [5]. Lima beans and hyacinth beans may also be heavily attacked by *M. testulalis*. Lima beans are more commonly atacked than are green beans.

Sub-Major Pests

There are three insects which are here recorded as sub-major pests of green bean. They are thus designated because, while they are not in general major pests, they are, at certain times and in certain places, more prominent than the insects recorded as minor pests and more important even than some of the insects recorded here as major pests. They are a leaf-feeding caterpillar and two pod-attacking insects.

Autographa chalcites (Esper.), Garden looper—Lepidoptera, Phalaenidae

The green looping caterpillar of this insect has been a pest in Hawaii for more than 30 years [14]. It feeds on the foliage of a large number of plants, including garden vegetables and ornamentals. It is generally found on the undersurface of the bean leaf, riddling the leaf with holes, but it does not skeletonize the plant as does *Adoretus sinicus*. Though the damage by this pest may be great, the insect was not very abundant on beans during the period of the observations recorded here. At Waipahu and Kaneohe it was more abundant during the winter than at other seasons. It has also been found on tomato, potato, Chinese pea, head cabbage*, and eggplant.

Cosmolyce boetica (Linné), Bean butterfly—Lepidoptera, Lycaenidae

The bean butterfly probably arrived from the Orient some years prior to 1882 [13]. The method of attack is similar to that of *Maruca testulalis*. The larvae destroy the flowers as well as the pods of leguminous plants. In localities where the infestation is high and uncontrolled, damage may result in a complete loss of the bean crop. Fortunately, although the butterflies are usually present in bean fields, damage by the larvae is rarely seen. Commonly eggs are

* Most of the green looping caterpillars on cabbage and related plants are now known to be the cabbage looper *Autographa brassicae* which has been recorded on four of the islands of the Territory [12]. However, *A. chalcites* is also found on cabbage.

abundant on and near the floral parts, but seldom does injury result. Swezey (Proc. Haw. Ent. Soc., 7, p. 287, 1929) has recorded *Trichogramma minutum* as a parasite of the egg. Other economic hosts are broad bean, lima bean, hyacinth bean and pigeonpea.

Dacus cucurbitae Coquillett, Melonfly—Diptera, Trypaneidae

The melonfly was introduced from the Orient, as an immigrant, about 47 years ago and became established in the Territory[13]. This relatively large yellow and brown fly attacks the fruits of cucurbits, tomato, and some of the legume family. It damages the pods of beans by laying eggs beneath the surface. The maggots, on hatching from the eggs, feed and develop in the pod, making it unsalable. Although this insect was reported to have been very destructive to beans about 9 or 10 years ago at Lualualei, observations made during the past few years have brought to light damage at Koko Head and Waialua only. Observations made at Koko Head suggest that the presence of a high population of flies and the absence of more attractive hosts are important factors in damage to beans[6].

Minor Pests

There are several insects commonly found on garden beans which are at the present time considered as minor pests. Some of them may, at times, produce somewhat more damage than is ordinarily associated with minor pests. Should they increase in numbers it may be necessary later to rank them as major pests. The corn earworm, three-cornered alfalfa hopper, thrips, mealy bugs, certain species of aphid, grasshoppers, flea beetles, a cutworm, an ant, bean weevils and a leaf miner are here considered to be minor pests. They are as follows:

Orthoptera, Acrididae: *Atractomorpha ambigua* Bolivar
Orthoptera, Tettigoniidae: *Elimaea punctifera* (Walker)
Thysanoptera, Thripidae: *Thrips hawaiiensis* (Morgan); *Thrips tabaci* Lindeman
Homoptera, Aphididae: *Aphis gossypii* Glover; *Aphis sacchari* Zehntner; *Myzus persicae* Sulzer; *Rhopalosiphum nymphi* (Linné)
Homoptera, Coccidae: *Phenacoccus gossypii* Townsend and Cockerell; *Pseudococcus kraunhiae* (Kuwana)
Homoptera, Membracidae: *Stictocephala festina* (Say)

(This last mentioned species, the three-cornered alfalfa hopper, was probably introduced accidentally into Hawaii from California, on hay, about 17 years ago[2]. Adults and nymphs have been found comparatively abundant on beans at Waipahu and Waialua. It is present also at Kailua, Kahuku, Koko Head, Kaneohe, Honolulu, and Lualualei. Although it may be abundant at times, it is considered to be a minor pest.)

Coleoptera, Bruchidae: *Bruchus chinensis* (Linné); *Acanthoscelides* (*Bruchus*) *obtectus* (Say); *Bruchus pruininus* Horn
Coleoptera, Anthribidae: *Araecerus fasciculatus* (De Geer); *Araecerus vieillardi* (Montrouzier)
Coleoptera, Chrysomelidae: *Diachus auratus* (Fabricius); *Epitrix parvula* (Fabricius)

(Seeds and dry pods of beans in storehouses are often attacked and destroyed by several species of weevil. Though not as abundant and injurious in the field as in storage, these weevils may become of great importance when pods are left to ripen and dry on the plant.)

Lepidoptera, Phalaenidae: *Heliothis armigera* (Hubner)

(At the present time, *H. armigera* is not considered to be a major pest of beans in Hawaii although it caused serious damage to bean pods at Waimea, Hawaii, in October, 1939. It would appear that a high population of the corn earworm moths and paucity of corn or other hosts more attractive than beans are factors in the attack of this insect on beans. Until further evidence is secured to the contrary, *H. armigera* is therefore designated a minor pest of beans.)

Lepidoptera, Phalaenidae: *Agrotis ypsilon* (Rottemburg) (Bean plants recently germinated are often cut off just above ground level by this cutworm)
Lepidoptera, Tortricidae: *Amorbia emigratella* Busck (The larva has been found attacking bean leaves)
Diptera, Agromyzidae: *Agromyza* sp. probably *pusilla* Meigen
Hymenoptera, Formicidae: *Solenopsis geminata* Fabricius race *rufa* (Jerdon) (The ants chew roots and stems at or about ground level).

Beneficial Insects

Although many of the insect pests of Hawaii have been brought under control by biological means, most of the enemies of the garden bean are not attacked to any great extent by beneficial insects. Ladybird beetles are the commonest found. Of the seven species collected on beans, *Coelophora inaequalis* (Fabricius) is the most abundant and undoubtedly the most efficient enemy of aphids and mealy bugs. Several species of wasp have been observed attacking larvae of *Maruca testulalis* and other caterpillars. The number of wasps working at one time is usually small. While they must exert some control, and, at times an appreciable control, they cannot at the present time be regarded as a major factor in controlling the borer. Predaceous bugs are invariably present on bean plants. Aphids are no doubt commonly attacked. *Zelus renardii* Kolenati

was particularly abundant at Lualualei where it has been seen preying on adults and nymphs of *Pycnoderes quadrimaculatus*.

The following species of beneficial insects have been recorded:

Orthoptera, Tettigoniidae: *Conocephalus saltator* (Saussure); *Xiphidiopsis lita* Hebard (Both these species have been reported by Swezey [16] to prefer an insect to a vegetable diet)
Neuroptera, Hemerobiidae: *Eumicromus navigatorum* (Brauer)
Hemiptera, Anthocoridae: *Triphleps persequens* White
Hemiptera, Nabidae: *Nabis capsiformis* Germar
Hemiptera, Reduviidae: *Zelus renardii* Kolenati
Coleoptera, Coccinellidae: *Coelophora inaequalis* (Fabricius); *Coelophora pupillata* (Schön); *Cryptolaemus montrouzieri* Mulsant; *Diomus notescens* (Blackburn); *Platyomus lividigaster* Mulsant; *Rodolia cardinalis* Mulsant; *Pullus loewii* Mulsant.
Diptera, Dolichopodidae: *Chrysosoma fraternum* Van Duzee
Hymenoptera, Vespidae: *Polistes fuscatus* (Fabricius); var. *aurifer* (Saussure); *Polistes hebraeus* (Fabricius); *Polistes macaensis* (Fabricius)
Hymenoptera, Eumenidae: *Pachodynerus nasidens* (Latreille) (Adults attack larvae of *Maruca testulalis*)
Hymenoptera, Braconidae: *Chelonus blackburni* Cameron; *Ischiogonus palliatus* Cameron
Hymenoptera, Ichneumonidae: *Cremastus flavo-orbitalis* (Parasite of *Maruca testulalis*)
Hymenoptera, Encyrtidae: *Litomastrix floridana* (Ashm.) (Parasite of *Autographa chalcites*)

Incidental Insects

The following additional insects have been recorded on the garden bean. Some of them no doubt feed on the bean plant. Some, especially the sap-sucking insects and particularly the aphids, are potential vectors of virus diseases. The role of others is unknown. Some are possibly casual insects present on the bean plant merely because of proximity of their common hosts. Further observations would no doubt reveal the true relation of many of these insects to the plant.

Homoptera, Aphididae: *Macrosiphum gei* Koch; *Micromyzus formosanus* (Takahashi); *Aphis maidis* Fitch
Homoptera, Cixiidae: *Oliarus discrepans* Giffard
Homoptera, Delphacidae: *Aloha* sp.
Homoptera, Flatidae: *Siphanta acuta* (Walker)
Heteroptera, Lygaeidae: *Geocoris punctipes* (Say); *Nysius terrestris* Usinger; *Nysius nigriscutellatus* Usinger
Heteroptera, Capsidae: *Cyrtopeltis varians* (Distant); *Leucopoecila albofasciata* Reuter

Heteroptera, Tingidae: *Teleonemia scrupulosa* Stål.
Coleoptera, Cerambycidae: *Cyllene crinicornis* (Chevrolat); *Sybra alternans* Wiedemann
Coleoptera, Cucujidae: *Cryptamorpha desjardinsi* (Guérin); *Psammoechus insularis* (Sharp)
Coleoptera, Curculionidae: *Anthonomus eugenii* Cano; *Pantomorus godmani* (Crotch)
Coleoptera, Scarabaeidae: *Anomala orientalis* (Waterhouse)
Coleoptera, Elateridae: *Conoderus exsul* (Sharp)
Coleoptera, Nitidulidae: *Carpophilus dimidiatus* (Fabricius); *C. hemipterus* (Linné); *Urophorus humeralis* (Fabricius)
Coleoptera, Cleridae: *Tillus notatus* Klug
Coleoptera, Anthribidae: *Phloeobius gigas horaeus* Jordan
Lepidoptera, Phalaenidae: *Laphygma exempta* (Walker)
Lepidoptera, Tineidae: *Ereunetis simulans* (Butler); *Opogona aurisquamosa* (Butler); *O. purpuriella* Swezey
Lepidoptera, Tortricidae: *Argyroploce illepida* (Butler)
Diptera, Anthomyiidae: *Atherigona excisa trilineata* Stein (Probably a scavenger breeding in injured pods or other injured plant parts).
Diptera, Drosophilidae: *Drosophila melanogaster* Meigen

Summary

This is the first article in a series which will be devoted to the insects of crops, other than sugarcane and pineapples, in Hawaii. In it are recorded the results of a survey of the insects of garden bean. Most of the observations were made on the island of Oahu where most of the beans are produced. The relative importance of the insects has been recorded and the major pests determined. Eight major pests, three sub-major pests, twenty-three minor pests and twenty-two species of beneficial insects are recorded. The major pests have been classified on an ecological basis. They are a foliage-consuming beetle, *Adoretus sinicus* (the Chinese rose beetle), six sap-sucking insects including mites, *Empoasca solana* (the bean leafhopper), *Pycnoderes quadrimaculatus* (the bean capsid), *Aphis medicaginis* (the cowpea aphid), *Trialeurodes vaporariorum* (Westwood) (greenhouse whitefly), *Tetranychus* sp. (a red spider mite), and *Hemitarsonemus latus* (the broad mite), and a pod-attacking insect *Maruca testulalis* (the bean pod-borer). Sub-major pests include *Autographa chalcites* (the garden looper), *Cosmolyce boetica* (bean butterfly) and *Dacus cucurbitae* (the melonfly).

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